THE EAST AFRICAN AGRICULTURAL JOURNAL

Issued under the Authority of the East African Governors' Conference and published every other month
JANUARY, MARCH, MAY, JULY, SEPTEMBER, NOVEMBER

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Editorial correspondence should be addressed to the Editor, Amani, via Tanga, Tanganyika Territory. Matter submitted for publication should preferably be sent through the local member of the Editorial Board.

EDITORIAL NOTES

The Report of the Director of the Department of Veterinary Science and Animal Husbandry of Tanganyika Territory reviewed on another page begins with a statement of the policy of the Department, called forth doubtless by the questions which have been raised regarding the justification of its activities in relation to public policy. The subject has fundamental importance and Mr. Hornby argues his side of it thoughtfully and clearly. More than 95 per cent of the live stock of the Territory is native-owned, and the vicious circle imposed by natural conditions is thus described :

"A study of the distribution of the live stock of the Territory shows clearly that the native husbandman is only capable of maintaining large flocks and herds on land the vegetation of which is indicative of arid or sub-arid conditions. Fertile soil blessed by good rainfall cannot be utilized by him as it should be, that is for the maintenance of a reasonable number of animals on land with persistent vegetation cover, since such conditions favour ticks, flies and worms against the ravages of which the native is helpless without veterinary aid. Thus the parts of the Territory which are agriculturally the best are normally deprived of cattle and sheep by tsetse, ticks and worms, and the only ways the native knows of making them available for stock are by measures which favour erosion and bring about soil aridity even in the presence of good rainfall. Conditions of natural aridity are found throughout much of Masailand; whereas a state of artificial aridity unfavourable to disease and thus encouraging over-stocking has been produced in Usukuma.

Examination of a cattle map which my department prepared shows the following state of distribution :—

(1) Six-ninths of the Territory is tsetse-infested and cattle free.
(2) About one-ninth is so arid that it is comparatively disease free and stocked to saturation; the numbers being regulated by deaths from starvation.

(3) About two-ninths are free from tsetse owing to altitude and open nature of the country, and yet are understocked owing principally to enzootic East Coast fever causing more than 50 per cent mortality among calves."

To the suggestion that overstocking should be naturally controlled by allowing disease, especially rinderpest, to operate unhindered the reply is made that in overstocked areas mortality from starvation is already a more potent control, while rinderpest, if allowed free scope, would ravage the mountain grassland areas where cattle form a valuable asset.

The first aim of the Department is the suppression of disease to the extent judged to be economically justifiable. As regards distribution the objects in view are: in mixed farming areas to limit numbers to those which the land can carry without deterioration and with reference to local needs; in pastoral areas to secure conditions which permit seasonal rotational grazing and free marketing of oxen; in understocked areas to increase numbers to the extent of providing milk, manure, and possibly traction, the main meat supply to come from outside.

Within these general lines of policy are included the improvement of the value of live stock products and, most important of all in relation to the general well-being of the native population, the co-ordination of the live stock trade of the country by the provision and supervision of stock-routes, markets and abattoirs, so that in return for cheap healthy meat, money may flow from areas of export crop production to those where cattle form the only marketable produce. It is the opinion of many, including the present writer, that it is in this direction, the removal of the social and economic barriers which exist between large meat-hungry populations on the one hand and cattle infested districts on the other, rather than in the search for external markets, that the solution of the cattle problem is to be found.

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BULBS.

The Department of Agriculture, Kenya Colony, has received a request from the Trade Commissioner for H.M. Eastern African Dependencies, London, to put him in touch with farmers who are in a position to export Gladioli and other bulbs from Kenya. Any farmers who are producing bulbs for sale already, or are likely to be interested in the production of suitable bulbs, if it appears at a later date that there is a prospect of an export trade, are requested to write to the Director of Agriculture, Nairobi.

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It is known that many people maintain records of rainfall who do not send in returns to the Meteorological Service. As the amount of labour involved in filling up and sending in a monthly return is slight, the Director of the B.E.A. Meteorological Service, Box 931, Nairobi, would be grateful if anyone willing to submit such returns would communicate with him. The more complete the rainfall data can be made, the greater use it will be to all investigators, especially to the Agricultural and Meteorological Departments.

Research Notes

THE CARBON-NITROGEN RATIOS OF AUSTRALIAN SOILS (J. S. Hosking, in *Soil Research*, IV, 3, 1935).

Organic residues accumulate in a soil, or are broken down and disappear, in conformity with a very mixed lot of local circumstances, and an analysis of a cultivated soil for carbon and nitrogen usually tells us very little about its state of fertility. It certainly does not yet afford guidance on policy in organic manuring. For that reason, agricultural chemists working to practical ends have not bothered much with precision measurements of these elements in soil, and the recorded data are scattered, not very plentiful even for soils that have been much worked upon, and often seriously uncertain in accuracy. Most of the factors that govern soil organic matter, however, are also those that determine soil type and its modifications under tillage or pastoral management, and it is a reasonable expectation that with advancing security in the principles of soil classification, progress will be made towards the recognition of a "norm" for content and character of organic matter in particular soils.

The paper here noticed attempts an advance into this difficult field, and certainly clears the ground of some easily entertained misconceptions. Australian conditions no doubt differ widely from African, but in both continents the climatic range is considerable, with a number of corresponding vegetation and soil types, and in both the use of fire has been almost universal in preparing land for cultivation. Data for 618 samples are examined statistically, after arranging them according to the main groups of Prescott's Australian classification. As regards total content of organic residues (which in most cases must include more or less charcoal) there is a marked distinction between the humid types as a whole, in which carbon content ranges up to 8 per cent and occasionally more, and the semi-arid to arid types, in which carbon content is usually less than 2 per cent. The figures vary greatly not only between types but also within any particular one, an effect that is no doubt due to the use, without sub-grouping, of samples from sites of all kinds from virgin to intensely cultivated, which conveys an impression of disorderliness that cannot, one still feels, be the entire truth. It is clearly necessary, in these statistical surveys, to deal if possible with homogeneous material—no easy requirement to fulfil with a creature of such infinite diversity as soil, simultaneously with the necessity for large numbers of samples.

As regards the carbon/nitrogen ratio, the general conclusion is that it varies over much the same range for all climatic conditions and soil types, but that soils under grassland cluster much more closely about their mean values than do soils under woodland, where the conditions lead to greater variety in the sources of organic matter. The mean values for all types except semi-desert lie between 20 and 11. In view of the extreme values sometimes offered for belief in the literature, it may be noted that of the 618 soils only 4 had C/N ratios lying outside the limits 40 and 6.

East African data so far available, though not yet so numerous as the Australian and hardly ripe for this kind of statistical examination, fit in remarkably closely with Hosking's general conclusions, though certain regularities are already observable here that may lead to constructive additions to the somewhat pessimistic picture he presents.

G.M.

RELATIONSHIP OF ROOTS, SOIL PROFILE AND IRRIGATION IN THE SUDAN, *by* F. E. Kenchington, *J.S.E. Agric. Coll., Wye*, July, 1935.

Possibly the most-investigated soil in Africa is the heavy alkaline clay of the regions adjoining the junction of Blue and White Niles, in the Sudan. Following an experimental period that began before the war, cotton growing on this soil under irrigation has been extended during the last ten years until something approaching 200,000 acres of difficult land, naturally a semi-desert, has been brought into production. It carries cotton usually every third year, the rotation being completed by a season under millet or pulse crop grown mainly on rainfall, and a season's fallow with power cultivation.

The unusual properties of this deep, tenacious, saline clay, which is so impermeable as to be practically waterproof below its middle horizon at depths of from 1 ft. to 4 ft., have no complete parallel, so far as is yet known, in any East African soil, nor has any part of these territories a region of such very low rainfall (in the Sudan cotton area it lies between 10 in. and 4 in. per annum) in active agricultural utilization. Analogous if less extreme conditions will be encountered, however, if some of our large areas of black "mbuga" clays and heavy alkaline alluvia are brought into production under irrigation, as is from time to time proposed. This full account of eight years' observation and experience on the Sudan cotton soils, more particularly the sub-type represented in the 4-inch rainfall zone just north of Khartoum, is by no means irrelevant reading for East Africans.

The content of the paper is too considerable to be summarized in a short note, but it includes studies of the reaction of varieties of the cotton plant to an abnormal habitat under a merciless system of watering, with charts of cotton root systems; inquiry into the contribution of measurable properties of the several soil horizons to the observed features of the profile as a whole; the effects, and the difficulties, of deep cultivation; the remote possibilities of achieving drainage, of which at present there is none; calculations of salt-additions through irrigation; and, last but not least, a review of the genetics of the Sudan cotton soil and its sub-types, and of their place amongst the heavy black soils of semi-arid regions elsewhere in the world. The colloquial name for such soils in the Sudan, *teen suda* (="clay black"), is suggested for general use as a world-name for the group, but it seems not a particularly happy choice, at least to those of us who have no Arabic.

Kenchington is despondent about the future of large-scale agricultural enterprises on these Sudan clays, which he considers are steadily worsening under "the succession of water-loggings which is irrigation"—a sufficiently frank definition. It is, however, necessary, on this particular point, to read the paper in conjunction with others* that have appeared

*Rainfall and Cotton Yields in the Sudan Gezira, E. M. and F. Crowther, in *Proc. Roy. Soc. B.*, Sept. 1935.
Drainage in the Sudan Gezira, articles and correspondence by Balls, Barritt, Dempster, Greene, and Bailey in *Emp. Cotton Grow. Rev.*, Jan., April and July, 1935.
Soil Problems in the Sudan, H. Greene, in *Proc. 3rd. Int. Congr. Soil Sci.*, July, 1935.
Effect of Irrigation and Dry Fallow on a Heavy Base-Saturated Soil, H. Greene and O. W. Snow, *ibid.*, 1935.

this year on various aspects of the same set of problems in the same region, though mainly referring to the Gezira proper, south of Khartoum. It is maintained that evidence for cumulative soil deterioration cannot in fact be found, either by study of the soil profile or as reflected in cotton yields. There has recently been a sequence of low yields from the region as a whole, but the major part of the increased area brought in since 1925 has so far borne only two or three cotton crops under the rotation adopted, and the annual figures for yield fluctuate so widely that they cannot be interpreted as indicating a lower intrinsic fertility, or indeed anything else, unless after critical analysis by modern statistical methods. Statistical analysis shows that whether or not the *soil* has worsened, the *weather* has done so undoubtedly—comforting support, as one author remarks, for the practical farmer, who has always said so. There has been demonstrably a succession of adverse seasons, probably running in a 7-year cycle; and the proved correlations of low cotton yield with high rainfall and with the incidence of an unseasonable proportion of it in May and June, some two months before sowing date, are of themselves sufficient to account quantitatively for the disappointments of recent years.

In face of one's instinctive distrust of soil conditions such as are described from the Sudan, it is encouraging to have a verdict that exonerates the soil from direct responsibility for the increasing difficulties of the cotton agronomist on the irrigated areas there. It would be unwise to conclude that irrigation without drainage is a blameless practice, and will always get let off so lightly. But the black soils of Africa, as a group, present a challenge to the agriculturist. As contrasted broadly with its red soils, they contain an idle accumulation of the inorganic chemical elements of fertility, and African agricultural science may increasingly be summoned to devise means of putting this stock into productive circulation. The subduing of the truculent Sudanese members of the black soil family is therefore a spectacle of first-rate public interest, gladiatorial in its setting and scale. Just now the gladiators are distinctly adding to the fun by their disagreements on whether they have or have not lost points to date, against the common adversary. There is also some barracking from experts in the crowd. The balance of the struggle is in fact held so evenly that a very little misfortune, as in weather, may turn the scale and bring defeat. In that lies the moral for East Africa.

G.M.

A Root Disease of Cacao

(ASSOCIATED WITH *USTULINA ZONATA* LEV.)

By G. B. WALLACE, *B.Sc., Ph.D., Plant Pathologist, Tanganyika Territory.*

A disease of cacao and of kapok growing together on a plantation in the Usambara Mountains has been found associated with the fungus *Ustulina zonata*. The disease had been known there for some years, but is only now diagnosed.

Other records of Ustulina in East Africa are as follows: In 1915, according to Wilkins (11, p. 332), Maitland found an Ustulina on a dead stump of *Phoenix reclinata* in Uganda. In 1922, the fungus was again recorded in Uganda by Small (5). In the same year McDonald (3) recorded Ustulina in pear and peach trees in Kenya.

In 1928, Staner (6) recorded Ustulina in Hevea in the Belgian Congo, and in that year Butler (2) found the fungus in Nyasaland in mature tea affected by Collar Crack (*Armillaria mellea*), and in young trees occasionally alone.

The fungus was recorded by the author (9) at Morogoro in Tanganyika Territory in 1933, when it was observed acting apparently as a parasite in an indigenous Acacia (*A. campylacantha*), and in 1934 it was noted (10) in the Flamboyante *Poinciana regia*.

SYMPTOMS.

The appearance of diseased cacao trees recalls at first sight the disease caused by Armillaria (8), but closer examination reveals the distinctions. Ustulina root rot agrees with root diseases in general in that the leaves droop and turn yellow and brown, finally falling and not being replaced by new foliage. The roots show no rhizomorphs or cracking, which are typical, although not invariably present, with Armillaria; it must be remembered that both diseases may occur in one tree, as has been observed in tea in Nyasaland. There is an absence in the Ustulina-diseased roots of the mushroom odour which characterizes Armillaria root rot.

Ustulina agrees with Armillaria in its drying action and production of black lines in the wood, and also in sometimes parasitizing the roots on one side of a tree first. In the latter case the foliage is seen to droop and wilt on the attacked side first.

In Ustulina the sheets of mycelium are smaller and more creamy white than in Armillaria, where they form large and uniform layers and are often pure white. The most characteristic feature of Ustulina is the feathery nature of the mycelium (Fig. 1). The latter is found in con-

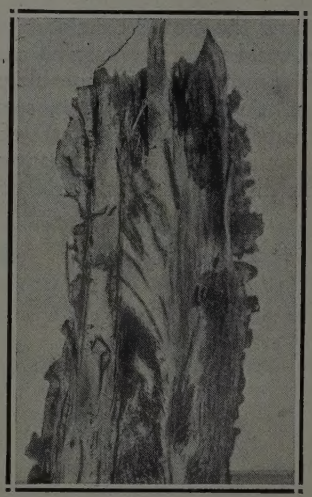

FIG. 1.
Ustulina zonata: feathery mycelium in bark of cacao.

siderable abundance under the bark and as layers in the bark tissue. In the wood it is microscopic and not visible to the naked eye.

In the affected Acacia mentioned above, which was eighteen inches in diameter, the mycelium was present in and under the bark of the trunk for a distance of twenty inches above ground level; in the roots it extended much further. The interval which elapsed between the first fructifications being seen and the final complete wilting of the foliage was very long—over sixteen months. By that time the fungus had permeated almost the entire root system.

Ustulina fructifications (Fig. 2) are diagnostic; they occur on the bark of the collar and sometimes on exposed roots, first as round white discs which grow to several inches in diameter and about one-

FIG. 2.
Ustulina zonata : old black and young grey fructifications

eighth of an inch thick; they follow the irregularities of the substratum. The margin is often uneven in outline. In the early stages of growth and on the growing margin white conidial spores are produced on the surface. Later the colour changes to a dull grey, on which can be seen dark dots; these are the mouths of the perithecia. The latter are buried in the tissue and contain the second type of spores—ascospores. It is doubtful to what extent the spores are responsible for spreading the fungus, but there is evidence in India, Ceylon and Malaya that they can infect wounds. The fructifications finally turn hard and black, and persist for a considerable time as a brittle crust.

THE PARASITISM OF USTULINA.

There is, according to Wilkins (11), a tendency among recent writers on Ustulina to look upon it as a sequel to infection by some other fungus, and to consider it not a primary parasite. Some evidence supporting the latter consideration is afforded by the presence, in the cacao plantation mentioned, of dead cacao trees in which no sign of Ustulina (or other parasite) could be found, and which are believed to have succumbed partly to former neglect and partly to the hard cold nature of the subsoil on which the trees were growing. That plantation nevertheless produces some of the finest cacao in the world. Also the Acacia mentioned above was growing in a hard, dry, denuded soil.

According to Briton-Jones (1), the only other record of Ustulina on cacao is from the Gold Coast, and so far as can be ascertained it has little economic importance in that colony.

However, even if it should not be a primary parasite in the cacao, its presence is evidence of something seriously wrong with the trees among which it is found, and indicates that more than the removal of infective material is required to remedy the condition. The fungus aggravates any defective condition of the trees, and hastens their death.

Wilkins (11), in a host index including records up to the year 1932, does not

record *Acacia campylacantha, Poinciana regia,* and kapok, which have since been recorded by the present writer.

Control.

The measures recommended for control of Armillaria (8) apply to this disease. On the cacao estate where Ustulina occurs there may be difficulty in its eradication on account of the presence of old kapok and cassia trees, many of which are now dead or unhealthy. The parasite was not observed in the cassia, but that does not prove immunity of that tree.

The fungus spreads by contact of diseased roots of one tree with the roots of another, and possibly to some extent by spores. Every effort must therefore be made to remove all dead and unthrifty trees, including as much as possible of their roots. It is a waste of time and effort to dig a pit which does not extend far enough to facilitate the removal of the roots, for these are possible sources of future infection; this neglect is a common mistake in dealing with root diseases.

In addition to field sanitation, the general cultural conditions on the cacao estate are being ameliorated. Where replanting is done it is necessary that both soil and subsoil be deeply dug to ensure a more lively and healthy growth of the roots.

Should a small area be so thoroughly infected that adequate treatment cannot be carried out immediately, the area should be isolated by a trench deeper than the side roots of the crop, to prevent spread of infection to the trees surrounding it. As soon as circumstances permit, the area should be dealt with thoroughly.

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Report on Grassland Improvement in Kenya, 1934

By D. C. EDWARDS, *B.Sc., Agricultural Officer in Charge.*

TYPES OF GRASSLAND.

There are three different sets of problems to be dealt with, associated with zones of different climatic conditions. The grasslands can be divided into two main types consisting of vast areas of acacia-grass savanna, and comparatively small areas of grassland under the more favourable moisture conditions of the higher altitudes. This latter type is again divided into (*a*) the high moisture and low temperature areas, where *Pennisetum clandestinum* (Kikuyu grass) pastures already exist naturally or can be developed, and (*b*) what may be called the intermediate zone, where moisture conditions are comparatively high, but where Kikuyu grass is not important in the natural vegetation and does not succeed under cultivation, apparently as the result of the higher temperatures which obtain.

HIGH MOISTURE AND LOW TEMPERATURE AREAS.

Little survey work has been possible owing to financial considerations, and much detailed information has yet to be collected in connection with the above types of grassland. During the year, however, a tour was made through the natural Kikuyu grass areas of the country and the information obtained, together with previous investigations, affords an insight into the vegetation of this zone and important information on the direction of future pasture development.

Climate.—These comparatively small areas of the country are associated with the relatively high moisture and low temperature conditions of the higher altitudes. The rainfall is roughly from 40 to 60 inches, fairly well distributed throughout the year, and the altitude ranges from 6,500 feet to approximately 9,000 feet. The moisture conditions are actually more favourable than is indicated by rainfall figures alone, as in addition frequent mists, often almost daily in occurrence, contribute to the supply of moisture. The high altitudes of course result in comparatively low temperatures.

Soil.—The main type of soil is a deep latteric loam, known locally as Kikuyu red loam. It is derived from a porous lava rock, and has good physical properties. There are other less important soils, but the main factor in determining the vegetational type is climate.

Present Utilization.—Some of the most important European farming districts are included within these areas. Dairy farming is growing, and this appears to be the type of country in which it has most scope for development. Considerable portions of the areas under consideration are occupied by natives, chiefly agricultural tribes. The movement towards intensive management will concern European farming in the first instance, but some sort of parallel development appears to be inevitable in the more thickly populated native areas, such as the Kikuyu Reserve.

Vegetation.—The climax vegetation of this zone is forest, but over considerable areas the forest has been cleared, either in comparatively remote times by stockowning native tribes or more recently by European settlers, although large portions of this region remain untouched. Wherever the forest has been removed grassland stages of the plant succession follow naturally.

The forest varies in composition, but some of the characteristic trees are: *Olea*

chrysophylla Lam., *Olea Hochstetteri* Baker, *Podocarpus* spp., *Lachnopylis congesta* C.A.Sm., *Pygeum africanum* Hk., *Dombeya Mastersii* Hk., and, in the drier parts, *Juniperus procera* Hochst.

Immediately following the clearance of this forest, a herbage of *Pennisetum clandestinum* Hochst., usually with a proportion of *Trifolium Johnstonii* Oliv., (clover) appears. After a period, varying probably in different areas, this type gives place to another stage in the plant succession, consisting mainly of coarse tufted grass species. The most prominent of these over large areas is *Pennisetum Schimperi* A. Rich. and in smaller localized areas *Eleusine Jaegeri* Pilger. A number of finer grasses occur with these tufted species, one of the most frequent being an *Agrostis* sp., while in certain areas *Andropogon chrysostachyus* Steud. is important. Throughout the greater part of the areas under consideration, however, this stage in the plant succession is represented mainly by the two coarse species mentioned above.

The coarse grass stage is apparently very persistent, and there are considerable areas in the highlands which fall within this description.

After a further period, during which the natural regeneration of the vegetation towards forest is prevented, a herbage in which *Themeda triandra* Forsk. (Red Oat grass) is dominant takes the place of the coarse grass stage. Other species, such as *Hyparrhenia ruprechtii* Fourn., are frequently to be found in association with the *T. triandra,* and in small areas these are sometimes dominant. The greater part of the areas under consideration have reached this last described stage of the plant succession.

Factors Influencing the Plant Succession.—It will be seen that in the high moisture and low temperature region described, a retrogression in the vegetation is taking place where regeneration of the forest climax is prevented by utilization of the grasslands. Once the forest is destroyed in this climatic zone its return is a slow process, even if no retarding factors are at work. Fire has undoubtedly been the most important instrument in the destruction of forest, and it is still important over considerable areas in preventing the advance of the plant succession.

The changes outlined above are clearly connected with falling soil fertility. Kikuyu grass is associated with conditions of high fertility such as are produced under forest, while the other stages in the succession can be explained by a gradual fall in fertility, particularly with regard to organic matter. These changes probably vary in rapidity with the amount and nature of the rainfall experienced.

There is clear evidence that this retrogression can be arrested, and that the higher grass-stages of the succession can be obtained by increasing the soil fertility. The ease of accomplishing the change naturally depends upon the extent to which retrogression has taken place, but in all the areas examined concentration of stock and the consequent deposition of manure bring about a rapid change in the herbage. On the sites of old native *bomas* (herding-places), and where night paddocks have been situated on European-owned farms, a return to the Kikuyu grass stage has very frequently taken place, while the localized areas of *Eleusine Jaegeri* mentioned above are probably due to higher fertility conditions than those which produce the *Pennisetum Schimperi* herbage.

Value of the Types of Pasture Concerned.—The dominants of the coarse grass stage are very unpalatable to stock

and of little value for grazing, and *Themeda triandra*, although a valuable grass under conditions of very light grazing, is quite unsuited to anything approaching intensive management under the above described climatic conditions. In the areas under consideration the concentration of stock on *T. triandra*, even to a small degree, results in the return of the coarse species, *Pennisetum* and *Eleusine*. This is one of the main difficulties of pasture management in the high altitude areas, as, wherever attempts have been made to improve the grazing by paddocking near the homesteads of European farms, the coarse species tend to take possession of the land. This is particularly marked in the immediate neighbourhood of the buildings, where an area of the coarse *Pennisetum* herbage almost invariably exists. The Kikuyu grass-clover stage of the plant succession is well suited to intensive management, and under grazing conditions provides a highly desirable type of sward.

Suggested Pasture Management.—The main consideration in the management of this type of grassland is believed to be control of the organic matter of the soil. In order to develop a Kikuyu grass pasture it is necessary to increase (in most cases) and to maintain the soil fertility. Where the plant succession has not fallen back beyond the *Pennisetum Schimperi* stage this can be accomplished to a large extent merely by the concentration of animals into small paddocks, provided that all the dung is deposited in the paddocks or that the whole of the manure is eventually returned to the paddocks. Where the succession has fallen back to the *Themeda triandra* stage, the first effect of concentrating stock is a return of the coarse tufted species of the *Pennisetum* stage. Under these circumstances this stage may be very persistent, and cause considerable difficulty, and therefore it may be advisable to plough, thoroughly clean the land and plant with Kikuyu grass, at the same time increasing the fertility as much as possible by the addition of farmyard manure or by concentration of animals (as by night herding) on the area prior to cultivation.

It is evident, then, that in order to maintain Kikuyu grass pastures it is necessary to keep up the fertility of the soil, and this entails intensive management. Apart from the organic manure which will result from such management it will be necessary to provide for a supply of minerals such as phosphorus and calcium, but in this type of pasture, under high moisture conditions, we have a sward well suited to intensive management, and it should be possible to reduce mineral manuring to economic proportions.

It has already been mentioned that some of the most important European farming districts are situated within the high-moisture low-temperature areas. These stock districts include an area from Molo in the south to north of the Sergoit District, Upper Gilgil, Thomson's Falls, Limuru, Kikuyu, and the Kinangop Plateau, apart from a number of areas of lesser importance.

Experiments Connected with the High Moisture and Low Temperature Areas.

The new site of the central grassland experimental station at Kabete is at the edge of an area such as those described above. Climatic conditions are not quite typical, but it is within the Kikuyu grass vegetational type, and this grass is at present dominant over practically the whole of the farm. This centre is well suited to carry out work bearing on these areas in general. The work will, in the

first instance, mainly concern European agriculture but, as has already been pointed out, more intensive methods of stock farming are likely to be a necessary development in some of the thickly populated native areas.

This station is also a suitable place in which to conduct experiments bearing on considerable areas of good rainfall outside the range of Kikuyu grass.

The main sections of work already in progress connected with Kikuyu grass pastures are as follows:—

Intensity of Grazing Experiment.—The effects upon the natural Kikuyu grass pasture of different intensities of grazing are being studied. This experiment was established approximately two years ago, and information of value is now being obtained. The effect of the different grazing treatments upon the indigenous clover in the herbage is of particular interest.

Manurial Experiment.—A preliminary manurial experiment is in progress. The plots are not replicated, and the experiment is intended primarily to give information on the visible effects of the different fertilizers and combinations. Experiments on the same plan have been repeated on herbage of different types in two drier areas of the country. Judging from the effect on yield and botanical composition, it appears likely that the effect of mineral fertilizers on natural pastures is too small to be of any appreciable value except in the higher rainfall areas of the country.

Kikuyu Grass Strains.—During the year work has been started on the isolation of strains of Kikuyu grass. Material has been obtained from various parts of the highlands where this grass occurs, and established at Kabete. No accurate comparisons of the plots of different origin is possible yet, but from the appearance it is evident that different strains have been obtained.

Indigenous Clover Strains.—Distinct types of *Trifolium Johnstonii* (already mentioned as the indigenous clover of Kikuyu grass areas) have been observed, and the isolation and study of these types appears to offer a promising line of work. Small plots of three types have been established for a number of months, and the clovers have remained distinctly different in appearance.

Trials of a number of leguminous plants, both indigenous and introduced, of possible value for pasture are in progress, but as yet none compare favourably with *Trifolium Johnstonii* for the Kikuyu grass areas.

Hay Production.—Even in the high moisture areas suitable grasses for hay production are of considerable importance. As intensive management is developed the storage of fodder as hay and silage will become a necessity and, apart from this aspect, the use of hay in "flush" periods of growth of the Kikuyu grass will probably help to counteract tympanites or "hoven", which is troublesome on this type of pasture.

Various types are under trial for hay production, and a number show considerable promise. One of the best grasses for the purpose is the Australian strain of Rhodes grass (*Chloris gayana*), particularly as seed of this grass is available commercially. It has been found that at Kabete, where *Trifolium Johnstonii* occurs naturally, this clover has invaded Rhodes grass plots, especially where the establishment of the grass is somewhat poor owing to insufficient rain in the early stages of growth. The other leguminous plants tried as hay mixtures with this grass have given little promise, except types of lucerne, which have given somewhat better results.

Fodder Crops.—An attempt was made to establish an experiment to compare fodder crops suitable for ensilage and feeding green in these higher moisture areas but owing to the partial failure of the March rains it is necessary to start this experiment afresh. Of the crops at present in use, Napier grass (*Pennisetum purpureum*) is the most satisfactory, although there is a number of other types, both indigenous and introduced, worthy of trial.

Intensive Management Experiment.—With a view to exploring the possibilities of the intensive management of Kikuyu grass pasture, steps are being taken at Kabete to compare intensively managed pasture with pasture treated according to the prevalent extensive methods. In this work particular attention will be paid to the economic aspect of the two methods.

In the areas where this grass succeeds, development of animal husbandry should aim at regulation of the food supply, both in quality and quantity. This type of country is capable of higher production than is at present accomplished by the ranching, or at best semi-ranching, methods in practice. Under present conditions, animals range over comparatively large areas of natural pasture which, owing to reduced soil fertility, consists largely of the less desirable stages of the plant succession, as already explained. For the greater part of the year the grasses are in a mature condition and therefore less nutritious, and there are periods of scarcity of at least annual occurrence. In addition, there is a general deficiency of minerals, particularly calcium and phosphorus. The development of small intensively managed areas of Kikuyu grass and indigenous clover, together with the conservation of fodder produced in the growing season as silage and hay, is believed to be the best way of accomplishing the necessary regulation of the available food supply. The above-mentioned experiment is intended to gain information on the possibilities of mineral manuring and utilizing high yielding animals on this type of pasture.

Intermediate Areas.

These are parts of the country under comparatively high moisture conditions, but outside the high altitude areas in which Kikuyu grass pastures can be obtained. Districts such as part of the Trans Nzoia fall into this category.

Work is in progress with a view to assisting the development of more intensive methods of management. Considerable improvement can often be obtained in these areas by properly controlled intensive grazing of the natural pasture, but it is believed that in most parts the ultimate goal should be sown pastures of grasses and legumes. In certain portions of the country which were originally devoted largely to maize growing, an effort is being made to change over to mixed farming. In these areas it is necessary to make use of disused arable land which has often been impoverished to a large extent by cropping. One of the necessities for such districts is the provision of suitable grasses and legumes for sowing on these old arable areas.

Work bearing on the intermediate areas of the country is as follows:—

Isolation of Valuable Species.—A considerable number of species has already been tested at the Scott Agricultural Laboratories, and this work is being continued at Kabete.

The method of testing consists of three main stages: (1) Small observational plots under nursery conditions, where the material of a new plant is increased

and such qualities as seed production and establishment from seed are studied. (2) One-fortieth of an acre observational plots under field conditions, and (3) grazing tests. The work has not proceeded to this stage as yet, although some of the plots for the purpose were established during the inadequate March rains of last year. (4) Trial plots in various parts of the country.

A considerable number of types, both indigenous and introduced, are already being dealt with in (1) and (2) at Kabete, and the trials have been extended to Njoro, Kitale, Naivasha, and other centres. From the outset, particular attention has been paid to the indigenous species. The grasses and legumes which have so far given most promise were enumerated in the Annual Report of the Kenya Department of Agriculture for 1933, and there is little to add to this list, except that *Phalaris tuberosa,* obtained from Queensland, has shown some promise, and that species of *Digitaria* supplied by the Department of Agriculture of South Africa have shown remarkable qualities of drought resistance under the prolonged dry conditions of the past year.

The most important advance during the year in the work connected with the intermediate areas is the further progress of the trials of the Australian strain of Rhodes grass (*Chloris gayana*). Despite the unfavourable climatic conditions, this grass succeeded at a number of centres, notably at the Scott Laboratories, Ngong Veterinary Farm, and Njoro Plant Breeding Station. At the two former places sowings were made on a fairly large scale, rapid establishment was obtained, and valuable grazing provided, although the rainfall was considerably below what is normally expected.

It appears likely that this grass may meet the requirements for sowing down pastures on abandoned arable land over large areas of the country. On such old arable land it will usually be an advantage to sow a pasture rather than to wait for the gradual development of natural herbage. A number of indigenous grasses have given promise for this purpose, but Rhodes grass is the most promising species of which seed is available commercially.

One of the difficulties in this work is the lack of suitable pasture legumes. So far no suitable type has been found for use in these areas, although lucerne has given some promise, and certain others, such as *Lespedeza* spp., are worthy of further trial.

During the year, trials of *L. stipulacea, L. striata* and *L. sericea* have been made under exceptionally severe conditions in a number of areas, and, from the information to date, the annual *L. stipulacea,* or Korean variety, has proved by far the most successful.

Effect of Grazing on Natural Pasture.—At the two centres, Ngong and Machakos, experiments to test the effects of different intensities of grazing and of grass burning were continued. At Machakos the schedule of grazing treatments has now been carried through a complete year, and records of the effect on the herbage will be made when sufficient growth has taken place. According to the observations made throughout these experiments: (*a*) The removal of the accumulation of old growth is essential in a herbage dominated by *Themeda triandra* if this grass is to remain the dominant. (*b*) Either grazing or burning appears to have much the same effect, at least over the comparatively short period of these trials. (*c*) Heavy grazing with cattle does not appear to have had any detrimental effect; in fact, the ground

cover seems to be rather better on some of the heavily grazed plots.

Very rapid growth takes place in this type of herbage (*T. triandra* dominant) over two more or less short periods in the year, following rain. During these growing periods heavy stocking is necessary to prevent the development of coarse herbage, which becomes unpalatable and is neglected. Later, growth practically ceases, and extremely little or no grazing is available until the next growing season. This course of events is more marked under the erratic rainfall of the Machakos centre, which approaches the conditions of the low moisture areas. It implies that this type of pasture can only be regarded as of value for ranching, as, if it is to be utilized over the greater part of the year, the animals will be feeding on mature dry herbage for a considerable part of that time. There is a possibility that other grasses such as *Cynodon* sp., common in the Machakos area and already cultivated on Kilima Kiu Estate, and Rhodes grass, may materially prolong the period of grazing, but reliance will always have to be placed in the conservation of fodder, mainly as hay and silage. In this connection it may be mentioned that it has been shown in the Machakos district, under a rainfall of 22 inches per annum, that Napier grass can be cut for feeding green practically throughout the year.

The Comparatively Low Moisture Areas.

These are the acacia-grass savanna areas mentioned in the early part of this report. The type of vegetation is produced under a low (20 to 25 inches per annum) and erratic rainfall, with prolonged droughts. This type of grassland is by far the most important in point of area covered. It is occupied by native pastoral tribes and to some extent by European farms, as, for instance, in the Nanyuki district.

In this type of country stock farming, even under European management, must remain on extensive lines, and although the growing periods of a limited amount of pasture may eventually be lengthened by the provision of home paddocks of selected drought-resistant species, the main line of development must be looked for in control of the grazing to prevent deterioration from localized over-grazing and in the conservation of fodder as hay and silage.

Suggestions have been put forward for a scheme of control for the drier areas occupied by native tribes. The suggested plan entails the protection of areas in rotation, based on a knowledge of the periods required by the main herbage species to ripen seed. The areas would be demarcated by geographical boundaries, such as hills and rivers, and they would be protected in turn for a succession of seasons until after the seed has ripened, when they would be thrown open to grazing each season. In this way, the whole of any given area would be utilized and the periods of protection would only be of a month or two in duration each season. Since two periods of seed production each year would occur over the greater part of the country, fairly rapid regeneration could be expected.

It is believed that the application of these principles is not beyond the bounds of possibility for the stockowning native tribes. The point to observe is that, although rigid control would be required, the plan does not necessarily entail fundamental changes of custom: where a tribe is given to nomadic habits, it simply means control of nomadism.

As regards experimental work connected with these drier areas of the

country, trials of a number of drought-resistant species have been established at Naivasha, and a renovation of pasture experiment has also been set up.

Renovation of Pasture Experiment.—Locust attacks over the past two or three years and continued drought have resulted in marked changes in the herbage of some of the drier districts. In fenced areas on European-owned farms, where the effect of heavy grazing has been added to that of locusts and drought, in some cases the existing herbage consists mainly of annual weeds, with a small proportion of grasses only, and a large part of the ground surface is bare.

With a view to finding a rapid and sufficiently cheap method of bringing about recovery of these degenerate pastures, an experiment has been set up on the Government Farm, Naivasha.

The following methods are being compared:—

(1) The protection of an area by fencing; surface cultivation, and sowing of grasses and legumes.

(2) Surface cultivation and sowing of the species in an unprotected area. Replicated portions (*a*) untreated, (*b*) burnt, (*c*) dressed with phosphate.

(3) The protection of an area of the degenerate pasture by fencing, a part surface cultivated by harrowing.

(4) An area of the existing degenerate pasture demarcated as a control, neither protected nor sown. Part surface cultivated.

In this experiment both indigenous and introduced species have been used. Attempts have been made to establish four grass species and six legumes. The work was started in the short (November) rains of 1934. These rains practically failed, and conditions have been abnormally dry ever since, with the result that little germination of the seed has taken place, and re-sowing will probably be necessary in the approaching rainy season.

Main Lines on which Grassland Improvement is being Attempted.

The main lines on which progress is being attempted are as follows:—

(1) Determination of herbage species and strains suited to various areas.

(2) Development of intensive grazing methods where possible.

(3) The improvement of large areas of natural pasture by methods of rotational protection.

In connection with the development of intensive methods of management, this is, as already pointed out, only possible in parts of the country where moisture conditions are good. It is also dependent upon the possibility of utilizing species which are capable of withstanding intensive grazing.

In order to obtain information bearing on this matter, an experiment designed to determine the seasonal yields of herbage and nutrients of eighteen grasses was established at the Scott Laboratories in November, 1931. In July, 1932, a system of monthly cuts was started. Locust attacks made it impossible to obtain the information desired, but the cuts were continued throughout a year with the exception of the months of September, October and November, when it was only possible to cut a few plots owing to locust attacks.

In the course of the experiment it became evident that the majority of the grasses included were unable to withstand the frequent cutting. The yields were very low, and as the plants became weakened they were attacked by termites and destroyed.

Those which withstood the treatment best were:—

Pennisetum clandestinum.
Cenchrus ciliaris.
Panicum coloratum.
Amphilophis pertusa.
Paspalum dilatatum.
Chloris gayana.
Digitaria eriantha.

It was considered that some useful information might be derived from chemical analyses of the cuts made on these grasses at three points in the year—two following periods of maximum growth, January and April, and one following a period of minimum growth, March. These analyses are given in Table 1.

The area on which the experiment was established was natural grassland until 1930. One crop of potatoes had been grown and no manuring carried out. The soil is Kikuyu red loam, apparently rather poorer than the average. The altitude is 5,700 feet, and the average annual rainfall 38.69 inches. The plots were set out in a randomized block arrangement, each species being replicated in each of four blocks. In taking samples for chemical analysis the material from all four plots of a species was mixed.

These figures are remarkably good for East African grasses, and are comparable as regards crude protein and silica-free ash with British grasses under a similar system of cutting, although the composition of the ash is probably different. The difference expected between the analyses of samples taken at periods of maximum yield (January and April) and the cut taken at a period of minimum yield (March) is not apparent. This is probably due to the fact that growth had already started when the March cut was made.

There is no marked difference between the species, and the results appear to indicate that, given grasses which will tolerate intensive grazing, the nutritive value of pastures in the higher moisture areas of the country can be considerably improved by proper grazing management.

TABLE 1
DRY MATTER BASIS

GRASSES	Month	Crude protein	Total ash	Silica-free ash
Pennisetum clandestinum.	Jan.	19·72	9·81	6·32
	March	16·38	8·30	6·33
	April	20·51	10·51	8·61
Cenchrus ciliaris	Jan.	16·27	11·66	7·05
	March	16·60	13·28	6·56
	April	19·86	14·19	9·11
Panicum coloratum	Jan.	15·87	9·72	6·92
	March	23·90	10·40	8·85
	April	20·32	9·95	7·64
Amphilophis pertusa ..	Jan.	12·55	11·42	5·39
	March	14·45	12·64	6·36
	April	17·60	12·84	9·00
Paspalum dilatatum ..	Jan.	16·58	9·58	5·87
	March	16·06	10·73	6·31
	April	17·57	10·56	6·74
Chloris gayana .	Jan.	10·47	8·68	5·77
	March	15·32	10·18	5·90
	April	15·35	18·17	14·07
Digitaria eriantha	Jan.	16·82	11·08	6·30
	March	15·12	11·62	5·94
	April	17·69	11·27	6·52

It is of interest to compare figures obtained for some of the above grasses in March, 1931, under a system of infrequent cutting. The plots were at the same centre, and on the same type of soil. The samples were taken on three weeks' growth from cutting, and up to the time of sampling the grasses were cut twice a year only for hay.

(*Continued on page* 344)

Swedish Rye Biscuits

(This Article has been compiled from information kindly supplied to the Kenya Department of Agriculture by Mr. A. Bursell, of Ruiru.)

Swedish rye bread is now chiefly made in factories, which are able to make a perfect product with the aid of machinery. It is considered, in modern times, that the necessary oven takes up too much room in a home, and many of the ovens consequently have been removed; thus the art of rye bread-making is tending to be lost amongst the younger generation. However, a communal bake-house, with a large oven, is to be found in some villages.

The shape and constitution of rye biscuits varies in different parts of Sweden; in the north the biscuits are as thin as paper and are made of a mixture of barley and rye flour; farther south the biscuits are thicker and are made with rye flour alone or with a mixture of rye and wheat.

The best bread is made from three parts of whole rye flour (composed of the ground-up entire kernels of rye) and one part wheat flour. The addition of the wheat flour renders the biscuits more brittle.

It is difficult to make good rye bread from sifted or bolted flour since the dough becomes sticky, and if, therefore, made stiffer the resultant bread is hard.

Ingredients.

110 lb. flour (50 kilograms);

4 gallons 5 pints water (20-22 litres);

2 or 3 handfuls of salt;

Caraway seed to taste;

or proportionate quantities.

Making the Biscuits.

Care should be taken to ensure that the flour and baking tins are not cold. A sponge is made of the yeast added to lukewarm water, some flour and a little sugar; the consistency of the latter should be that of gruel. When light and spongy, this mixture is ready to be added to the dough.

While the sponge is fermenting the dough is prepared according to normal bread-making routine, the water used being lukewarm. The yeast-sponge should be added to the dough before the dough has been made stiff. A little milk and fat in the water improves the bread, and makes the dough easier to handle.

The dough should be kneaded until it is smooth, but the kneading required is not so much as that required for loaves or wheat bread; nor should the dough be as stiff as the latter doughs, or it becomes too elastic and cannot easily be rolled out into thin cakes.

The dough should now be covered up and left to rise in a suitable place in which the temperature is about 68° F. until the bulk has become nearly doubled.

The dough is now cut through and kneaded a second time in order to break the gas bubbles and to distribute evenly the carbon dioxide formed during the fermentation; subsequently the dough is allowed to rise a second time.

When the dough has risen again, a roll is made from a large piece of dough, from which slices are cut and shaped into little cakes, about four inches in diameter and half an inch thick. These little cakes are put on a tin sheet to rise.

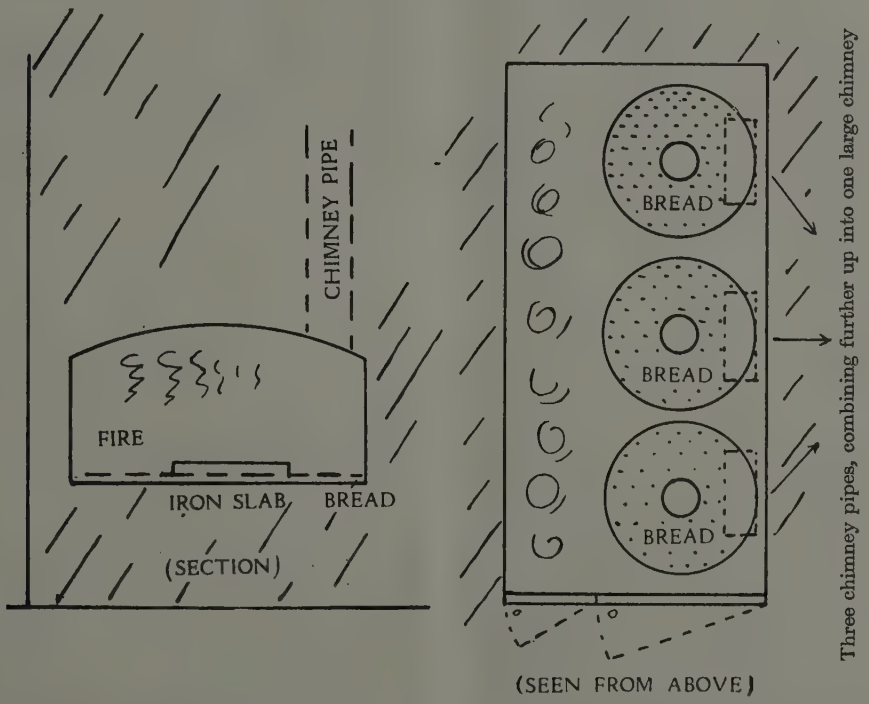
When the cakes are ready to bake in the oven they are rolled out very thin—the thinner the better—on a baking board which should be dusted with more

flour than is customary for ordinary baking purposes. The rolling cannot be done with an ordinary smooth rolling-pin; a special rolling-pin with sharp points is used (there are longitudinal and transverse grooves on the roller which divide the surface into small square segments). This type of rolling-pin does not adhere to dough like a smooth one, and pricks the bread so that it is made brittle, while large air-bubbles are prevented. The cake should be about 14 inches in diameter when ready, and should contain a number of little holes, derived from the roller. A round hole is now made in the centre of the cake with a biscuit-cutter, large enough to permit of sliding a pole through when the cake is baked. These thin cakes are not set aside, but are put straight into the oven.

There is some dexterity required in removing the cakes from the baking-board. The best way is for the operator to take the well-floured special rolling-pin with both hands, to press it down hard on the edge of the cake, so that it grips slightly, then to roll it lightly towards himself, so that the whole cake is rolled loosely around the rolling-pin. The cake is immediately unrolled on to the oven tin, and will then be right side up and ready to slide into the oven to bake.

The bread must be turned round in the oven in order to be baked evenly.

OVEN FOR THE BAKING OF SWEDISH RYE BISCUITS



When baked and cool, the cakes are brushed free from flour and are slid on a pole to dry. The pole should be hung in a warm dry place.

When the cakes are completely dry they are put away in barrels or boxes

with tight-fitting lids. If the biscuits warp while drying on the poles, they may be returned to the oven to make them softer or more pliable in order to facilitate packing them into the boxes, and so economize space. If the bread is perfectly dry, and is kept in a dry place, it will keep for at least six months.

The Oven.

The oven is built in various sizes. Large ones, which will hold six or more cakes are difficult to tend properly, so it is more usual to build ovens which will hold only three cakes at a time.

Sometimes the bottom of the oven is made of brick, but more often a heavy iron slab is employed; in either case, the bottom is laid upon a bed of small rocks, broken bottles, etc. Such a porous foundation tends to retain the heat well in the oven. The top or vault and the sides of the oven should be isolated in the same manner. The sketch shows the construction of the small-sized oven.

In order to heat the oven a fire is made which occupies the whole hearth. When the oven is thoroughly heated the fire is raked to the left-hand side of the oven, and the hearth is swept clean with a wet brush.

During the baking a small fire is kept up on the left-hand side of the oven. Finely chopped wood, free from resinous substances, must be used. When the oven is cooling down the fire must be built up again all over the hearth.

Sometimes the iron slab which forms the hearth is raised upon bricks, and the coals from the small side fire are raked down underneath the iron sheet. The reheating of the oven, then, is not necessary.

Notes on Conditions Influencing Quality in Coffee

By A. D. TRENCH, *Senior Coffee Officer, Kenya Colony.*

At the present time it is of paramount importance to the coffee planter to produce a marketable coffee, and such coffee must have "quality" in order to compete with mild coffees from other countries.

Questions are often asked regarding quality, as to what are the attributes which constitute or produce the property so called. The term is used in such a broad sense by the trade that no one seems to be able to give a clear definition of it.

This topic can be best dealt with by stating what, from experience in this and other countries, are considered to be the main factors which make a coffee of good appearance and good liquoring. The possibility of individual characteristics which might be produced by different varieties grown under identical conditions must first be taken into account. It would be unnatural to expect that all varieties of the species Arabica should possess identical characteristics. For example, Blue Mountain, Harar and Maragogipe, all grown under identical conditions, will produce individual characteristics, not only in the make of bean but also in body and acidity, particularly with regard to acidity.

The conditions which favour the production of coffee of good appearance with good liquoring properties are: (1) adequate rainfall, which is of primary importance—it has a great bearing on the colour and development of the bean; (2) in Kenya, altitude ranging from 5,500 to 6,000 ft., an even climate ranging between a mean minimum of 50° F. and a mean maximum of 80° F.; coffee bushes growing under such conditions will produce a uniform growth; (3) a deep soil with a heavy subsoil naturally well drained, the top soil with a deep zone of humus accumulation gradually merging into the subsoil. The soil must be kept in a high state of fertility. Good cultural methods must be adopted, with the object of producing a uniform crop. The bearing must be controlled to the capacity of the plant, as it stands to reason that if quantity is produced in excess of the capacity of the plant quality must be affected. The combination of as many of these factors as possible, with rainfall taken into account, will produce a commodity which has the best prospects of ready sale.

If conditions in the field are unsuitable for growing the crop, the quality will not be improved during the process of preparation. From the time the coffee is harvested (at the correct stage of ripeness) the inherent qualities cannot be improved: they can be maintained only, or even impaired.

During the last few years the rainfall, more particularly in the Central Province, has been very much below the average, and heavy rains have fallen during months when it is not usually expected. These unusual conditions have influenced out-of-season flowerings, and this has been particularly noticeable where out-of-season pruning has been carried out; the latter practice tends to throw the bushes out of their normal cycle of flowering. The former is uncontrollable; the latter is not. If the latter practice is remedied, the bushes will eventually resume the usual cycle of flowering when the seasons become normal. Out-of-season flowerings do not as a rule produce coffee of good quality.

Planters should make a closer study of the coffee bush, in order to be in a better

position to understand its requirements. It would appear that there is a tendency at the present time amongst planters to agitate for scientific investigation into cultural methods, and the writer, whilst appreciating the importance of this and the advancement which may be made, is of the opinion that the result of scientific work cannot be applied to the best advantage without, nor can it compensate for, a thorough knowledge of the fundamental principles and practices of agriculture. In general, far too little attention is given to the ABC of coffee-growing.

Whilst it is realized that the inadequate rainfall during the past few years has seriously affected the production of good coffee, it is considered that if more attention were paid to the principles of coffee-growing and recognized methods of preparation carried out with greater cleanliness and care, an improvement in the product should result. It is sometimes reported that low prices and severe criticisms of the product are received by planters who claim to have exercised the greatest care in the preparation of the bean, and high prices and glowing reports received by planters who admit that they have maltreated their coffee during preparation; but notwithstanding these contradictions it is still considered that the best results will be obtained by adopting recognized measures of preparation as a routine procedure.

Greater importance should be attached to the prevention or avoidance of—

(*a*) Overcropping.
(*b*) Soil deterioration.
(*c*) Out-of-season pruning.
(*d*) Drastic pruning.
(*e*) Unsuitable soil and climate.
(*f*) Diseases or pests.
(*g*) Drought.

With regard to drought conditions, over which the planter has no control, methods may be adopted whereby the detrimental effects of a low rainfall can be overcome to some extent. In this connection, thatching or mulching has been advocated, also certain methods of preventing soil erosion which are applicable to moisture conservation; for example, box-ridging.

A letter from a coffee planter in Guatemala is quoted in the *East African Agricultural Journal*, No. 2, September, 1935, p. 162. It is the present writer's experience that the opinions expressed, and the practices recommended, coincide with those generally accepted and adopted by planters producing mild coffees in the New World.

COFFEE THRIPS

A Contribution to our Knowledge of the Cause of Outbreaks

By F. B. NOTLEY, *M.Sc., A.I.C.T.A., F.R.E.S.*

INTRODUCTION.

The following article is an attempt to explain, on climatic grounds, the incidence of thrips (*Diarthrothrips coffeæ*, Williams) during the years 1932-35 in the Central Province of Kenya, and its incidence during an outbreak on different parts of infested plantations.

It should be stated at once that no finality is claimed for the conclusions arrived at, particularly as the meteorological records are mostly those from the Scott Agricultural Laboratories, where no thrips outbreak has occurred during any of these years; the records serve however as a guide to conditions over the area under consideration, namely the coffee belt of Kiambu, Ruiru and Thika. The Scott Laboratories stand near the south-westerly corner of this belt at an altitude of 5,700 feet.

The only published account of coffee thrips in the East African territories is Entomological Leaflet No. 2, Tanganyika Department of Agriculture, 1930, the species dealt with being *Physothrips xanthoceros*, Hood. The theory put forward in this leaflet is that epidemics of this thrips in the coffee areas of Kilimanjaro are due to drought conditions. Thus "In bad and exceptional thrips years, it has been the experience that drought sets in upon completion of the *masika* rains and little or no rain falls in the latter end of the year, not indeed until next *masika*" and "Thrips multiplication is a response to plant sap concentration upon onset of dry weather. So long as coffee retains a normal turgid leafage, thrips, while generally present in the plantations, remain in innocuous numbers. As a general rule tendency to multiplication may be looked for in those sections of the plantation where soils are thin, gravelly or shallow (as on denuded slopes or knolls), where shade is sparse or absent or where coffee is exposed to hot dry winds."

This theory, however, breaks down on occasion if applied to the Central Province of Kenya; for instance thrips damage was slight in 1933 when the long rains failed, though the coffee suffered very severely from drought, whilst despite heavy rain in February, 1935, when from 5 to 10 inches of rain fell in the Ruiru and Kiambu areas, a severe thrips infestation took place in March, 1935. In this year the Thika district did not get this rain in February and suffered severely from drought, yet the outbreak there was not so severe as in some parts of the Ruiru district, which had rain.

Local factors affecting the outbreak in 1935 appear to have been quite different from those quoted above. Thus the prevailing wind is from the east, and where thrips occurred it broke out earlier, and was most severe, on the western slopes and to the west of windbreaks, and was not so serious on coffee exposed to the wind.

The theory therefore requires examination from the point of view of conditions in the Central Province of Kenya. It is here examined in two separate ways; first to discover, if possible, the differences in climate between years when thrips causes damage and years when it does not, and secondly to discover the differences in climate during an outbreak

between areas in thrips infested coffee where severe damage is caused and areas where the damage is slight.

The Cause of Thrips Epidemics.

Thrips epidemics usually occur during the early months of the year, which are usually hot, dry months. The factors favouring an outbreak may therefore be lack of moisture in the soil, absence of rain, high temperature or low atmospheric humidity, or a combination of some or all of these factors.

Lack of Moisture in the Soil.

Since the coffee thrips spends its whole life on the aerial parts of the tree, the effect of low soil moisture content must be indirect. It should be stated here that slight thrips epidemics took place in May, 1933, and April, 1934, whilst a slight infestation in January, 1935, became a severe epidemic in March, 1935.

It is obvious that the reasons for an epidemic must be sought in the months preceding that epidemic. If the rainfall for the six months up to and including March of each year is examined, the following figures are obtained:—

Before April, 1935		Before April, 1934		Before April, 1933	
March	2·07	March	1·98	March	0·18
Feb.	6·21	Feb.	0·39	Feb.	0·00
Jan.	0·00	Jan.	0·37	Jan.	4·24
Dec.	2·75	Dec.	1·95	Dec.	5·25
Nov.	1·47	Nov.	3·54	Nov.	2·50
Oct.	2·27	Oct.	2·11	Oct.	1·59
Sept.	0·00	Sept.	0·30	Sept.	0·05
Total	14·77	Total	10·64	Total	13·81

The total rainfall which had fallen in these months was thus lowest in 1934 and highest in 1935. The thrips outbreak in 1935 could not therefore be due to lack of soil moisture, more particularly as the main epidemic took place in March, following the heaviest monthly rainfall in this period for these three years.

It must be admitted, however, that there does seem to be some correlation between the failure of the short rains and thrips epidemics, and also between poor soils and a high incidence of thrips during an outbreak, but in view of the failure of this correlation in the 1935 outbreak it would seem likely that outbreaks would more probably be due to some factor which usually, but not always, can be correlated with rainfall; for instance high temperature or low atmospheric humidity.

Absence of Rain.

Rain itself might have a direct influence on thrips, either by washing them off the coffee bush or drowning them in drops of water on the leaf. Two points, however, serve to destroy this theory. Firstly, this was not observed to happen during February, 1935, on coffee which was already infested in late January, though both heavy, beating rain and light drizzles fell during the month. Secondly, though thrips usually disappears on the onset of the rains, this disappearance is not sudden and immediate, as one would expect were the effects purely mechanical, but may suddenly occur for no apparent reason some time after the first rains, pointing to some other factor which usually accompanies rainfall.

Temperature and Humidity.

To avoid duplication of diagrams, temperature and humidity may be studied together by means of climatographs (Figs. 1, 2 and 3). In these diagrams the temperature scale is placed along the vertical scale, and the relative humidity on the horizontal scale, and

the points representing the mean monthly temperature and mean monthly humidity are joined in sequence. Thus in Fig. 1 it will be seen that for

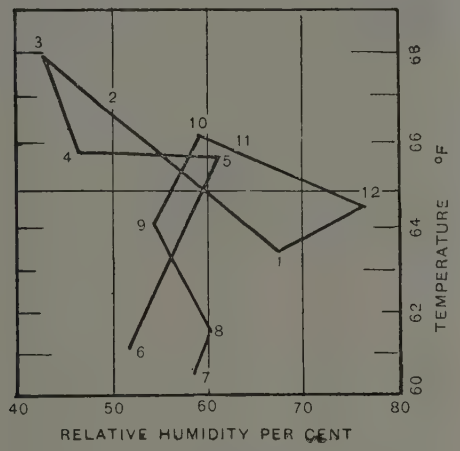


FIG. 1
Climatograph, Scott Laboratories, July, 1932 to June, 1933.

July the mean temperature was about 60.5° F. and the mean humidity just below 60 per cent. August was rather

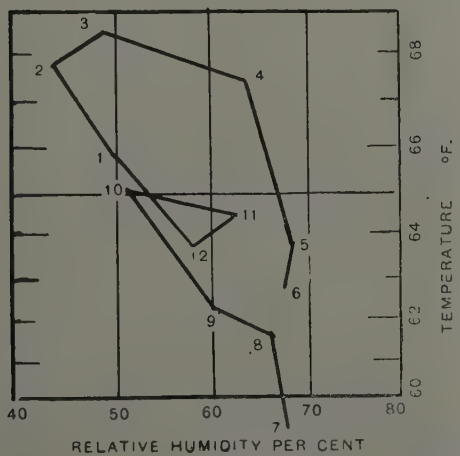


FIG. 2
Climatograph, Scott Laboratories, July, 1933 to June, 1934.

hotter, with much the same mean humidity. September was considerably hotter, and had a rather lower humidity.

A line is drawn across this figure at the temperature of 65° F., for reasons which will appear later.

At this point it is necessary to summarize briefly the history of thrips outbreaks in the three seasons in the area under review. Thrips caused slight damage in May, 1933, and in April, 1934: slight damage in January, 1935, and severe damage in March, 1935.

From an examination of Figs. 1 and 2 it will be seen that slight outbreaks of thrips occurred when the mean monthly

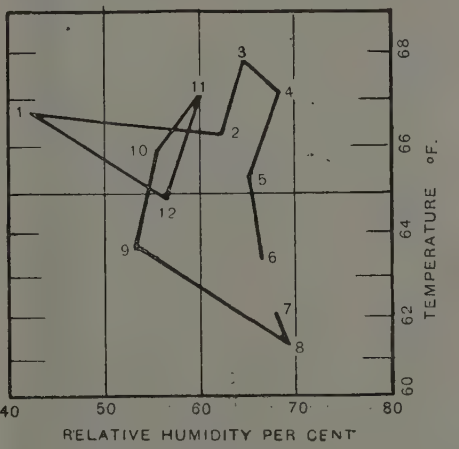


FIG. 3
Climatograph, Scott Laboratories, July, 1934 to June, 1935.

temperature had been above the 65° line for four months in succession, namely February, March, April and May of 1933, and January, February, March and April, 1934.

If four consecutive months with mean temperatures exceeding 65° are sufficient to induce a slight outbreak of thrips, it is clear from Fig. 3 which represents the

NOTE.—The small figures on the diagrams Nos. 1, 2, and 3 refer to the months, thus : 7=July, 8=August etc.

1934-35 season that a slight outbreak should have occurred in January, 1935, since the mean temperatures in October, November, December and January had exceeded this figure. Such an outbreak, comparable to the outbreaks of the previous years, actually took place. But the succeeding months also exceeded this "danger line" and a severe outbreak took place in March and April. The course of the outbreak will be considered in more detail below.

Figs. 4 and 5 are similar climatographs from the records of the Kasarini Field Station, which is considerably nearer to the thrips area. No outbreak of thrips,

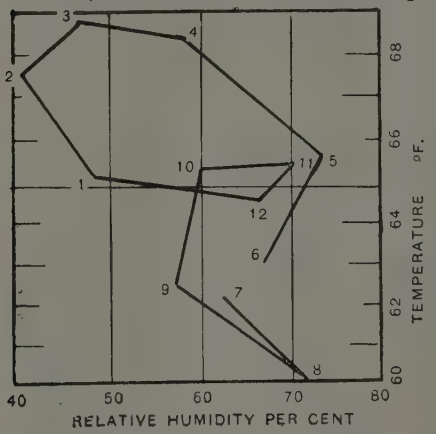


FIG. 4
Climatograph, Kasarini Field Station, July, 1933 to June, 1934.

however, took place on this farm. Unfortunately the records do not go back beyond 1933. It will be seen that the temperatures here are slightly higher than those for the Scott Laboratories in both years, but that they follow the same general lines. There are however some slight discrepancies. Since no outbreak took place at the station the figures show that the danger line should probably be placed considerably higher than 65° F. This figure of 65° is only chosen as indicating that when the average mean temperature at the Scott Laboratories has exceeded 65° F. for four months in succession, the thrips areas will have been experiencing temperatures

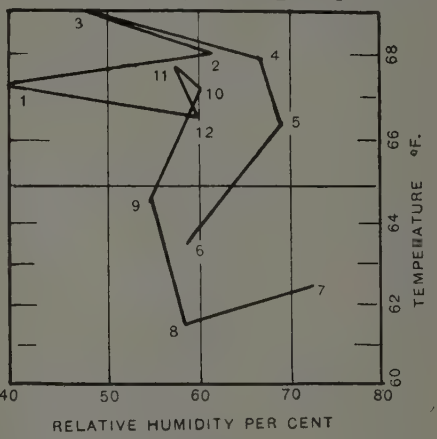


FIG. 5
Climatograph, Kasarini Field Station, July, 1934 to June, 1935.

which are above the danger mark. What the actual danger mark is cannot be exactly stated at present.

Now to consider the atmospheric humidity during this outbreak period. October, November and December had average mean relative humidities of between 55 per cent and 60 per cent. For January, when the first outbreak took place, the figure was 41 per cent, whilst for February, March and April the figures were 63 per cent, 65 per cent and 67 per cent. The humidity ranges for these four months were almost as large as the range for the whole three years.

The conclusion seems to be that atmospheric humidity does not have any great influence on a thrips outbreak, though it may be that a correlation does exist which is not revealed by the average mean figures.

NOTE.—The small figures on the diagrams Nos. 4 and 5 refer to the months, thus : 7=July, 8=August, etc.

The four factors, soil moisture, rain, temperature, and atmospheric humidity which on previous evidence might seem to be involved in the development of an epidemic of thrips, have thus been examined, and on the evidence of these three years it would appear that none of these factors, except temperature, is responsible for an epidemic. A high temperature, maintained over a sufficient period of time, is sufficient to cause an outbreak of thrips, and this outbreak will occur regardless apparently of either soil moisture, rain, or atmospheric humidity.

THE SUBSIDENCE OF AN EPIDEMIC.

An epidemic, once started, usually disappears on the onset of rain. In 1933, however, the outbreak which threatened in May disappeared in June, despite the fact that very little rain fell. Again, the heavy rain of February, 1935, failed to control the epidemic which took place in March.

On the other hand the minor outbreak of 1933 disappeared in June, and that of 1934 disappeared in May, and in each of these months there was a very large drop in temperature.

The conclusion seems inevitable, and is supported by general opinion, that the cause of thrips disappearance is due to cold, and not to the actual onset of rain. The fact that the onset of the rains usually brings with it a drop in temperature has served to disguise this correlation in a good many cases.

Fig. 6 is a diagram of the daily maximum and minimum temperatures at the Scott Laboratories from January to June, 1935. From observations of farms where thrips outbreaks took place during this period a close correlation between these temperatures and the course of the outbreaks may be shown. Thus at the end of January, when the first outbreak took place, very high maximum temperatures were recorded. During February a severe check took place in the outbreak; not sufficient to clear up the thrips but sufficient to prevent further damage being done until the second half of March and the first week of April. At this time very serious damage was done; again coinciding with a period of high maximum temperatures.

During the last three weeks of April and the first week of May thrips still persisted but did not do a great deal more damage, but between the 6th and the 7th May thrips disappeared completely. This period coincided with a sudden large drop in maximum day temperatures.

The general trend of minimum night temperatures is a steady rise from January until March and April, followed by a fall, whilst the mean temperature curve is simply half way between the maximum and minimum curves.

There is thus a striking correlation between the intensity of the outbreak and maximum day temperatures, but there is insufficient evidence to decide whether minimum night temperatures have any influence on the course of the outbreak, except that the large drop in maximum temperatures in February, unaccompanied by a drop in minimum temperatures, checked, but did not clear up the outbreak, whilst a very similar drop in maximum temperatures during May, followed by a large drop in minimum temperatures, was contemporaneous with the final clearing up of thrips.

If the disappearance of thrips is due to low temperatures, this lends additional weight to the theory that a thrips epidemic is caused by high temperatures.

LOCAL CONDITIONS AND THRIPS.

It is very noticeable that in a thrips epidemic, certain areas suffer much more

severely than others. In general, coffee at the higher altitudes does not suffer, whilst in areas which do get epidemics, the outbreaks are earlier, and most serious, in three positions:—

(1) On the leeward side of slopes.
(2) Behind windbreaks.
(3) On poor soils.

explained in terms of temperature alone. Vice versa, if these local conditions cannot be explained in terms of temperature alone, then the main theory cannot be upheld.

The fact that thrips outbreaks do not occur at higher altitudes immediately

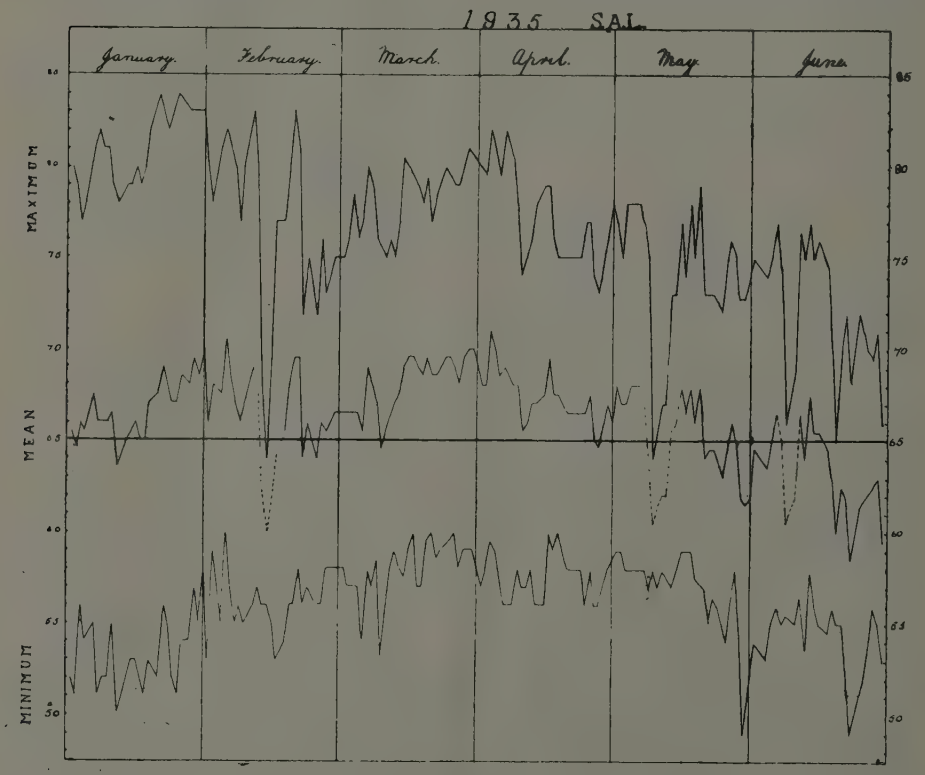


FIG. 6

Daily Temperatures, Scott Laboratories, January to June, 1935.

Now if the theory put forward above, that the only factor which governs whether a year is to be a bad thrips year or not is a temperature factor, then it follows that the local conditions which determine the intensity of thrips infestation during an outbreak must also be lends weight to this temperature theory, since there is no obvious factor except temperature, which is very closely bound up with altitude, likely to be involved. The remaining areas where thrips outbreaks are to be looked for will be examined separately.

Leeward Slopes.

The prevailing wind in this area is from the east, the leeward slope is therefore a western slope. The wind, though it may be a drying wind, is also a cooling wind for two reasons; first it will sweep away air which if stationary would tend to get heated by radiation from the ground, and secondly it will assist evaporation from the surface of the coffee leaf.

It should be remembered that thrips live in very close contact with the under surface of the coffee leaf, so that the temperature of the environment in which they live, though it will follow in the main the temperature of the air as recorded in meteorological screens, may be greatly influenced by the leaf itself. The majority of the water-evaporation of the plant takes place from the lower surface of the leaves, and this evaporation involves a considerable cooling of the leaf to supply the latent heat of vaporization of the water. Thus the environment of the insect may be at a considerably lower temperature than that of the air outside that environment, and this effect will be increased by the effect of the wind, which will increase evaporation.

Now the western, leeward, slope receives the full glare of the sun during the afternoon, when the highest temperature are recorded, so that the maximum temperatures will be higher on the western than on the eastern slope. In addition to this, these slopes are sheltered from wind, so that evaporation, and consequent cooling of the environment of the insect, is reduced.

Fig. 7 is a diagram showing the average hourly temperatures over a period of eight days recorded simultaneously by two self-recording thermographs, one placed on the windward side of a slope and the other on the leeward side, about one hundred yards apart. Both were placed at 2 feet above the ground between the rows of coffee. It will be seen that the maximum temperature is considerably higher on the leeward slope whilst the minimum is also a little higher; and that whilst the temperature on the windward, eastern slope exceeds

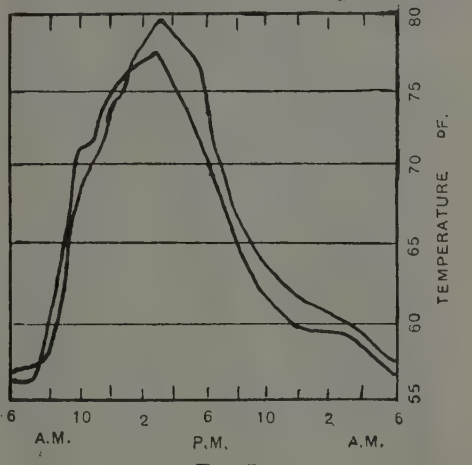


FIG. 7
Average Hourly Temperatures, Windward and Leeward Slopes.

that of the leeward slope during the morning, that of the leeward slope is higher during the afternoon and throughout the night. The difference during the night however is too small to be significant.

As a whole, the average temperature of the leeward slope is higher than that of a windward slope, whilst the maximum temperatures are considerably higher on the leeward slope. If high temperature is the factor which induces thrips outbreaks, then it should be expected that these outbreaks would be more severe on the leeward slopes.

Windbreaks.

Precisely the same reasons would explain the prevalence of thrips on the lee

side of windbreaks as on the lee side of slopes, both as regards air temperatures and as regards evaporation from the leaf.

Poor Soil.

The prevalence of thrips on coffee growing in poor soil can again be explained by reference to temperature alone. Two factors may be involved. The first is the poorer growth of such trees, which results in the poorer shading of the inside of the bush during the day. This will mean a higher day temperature inside the bush, which will probably only partially be counteracted by a lower night temperature. Again there will be less shading of the soil.

Possibily more important, however, is the less effective lowering of the temperature at the surface of the leaf by evaporation of water. Coffee growing on poor soil shows by its smaller, tougher leaves its struggle to conserve moisture by reducing this evaporation. This theory is strengthened by the fact that where coffee bushes are infested by thrips, the older leaves are more severely attacked, whilst young tender leaves, which evaporate water rapidly, are not so severely attacked.

The effect of this competition for water was most marked in one instance where in adjacent blocks of coffee, separated only by a narrow roadway, the one block planted 8 ft. by 8 ft. and the other 9 ft. by 9 ft., the first block was severely attacked whilst the second was not so seriously attacked.

It is necessary here, however, to examine the alternative theory put forward in the Tanganyika leaflet, that "Thrips multiplication is a response to plant sap concentration". Here a factor is introduced which so far has not been mentioned in this paper, namely food. Apart from the fact that this theory is negatived by the considerations in the first part of this paper, where it is shown that the rainfall had been heavy just previous to the thrips outbreak of 1935, it seems unlikely that thrips should multiply simply because they are offered a more concentrated food. There is no other recorded case of such an occurrence in the writer's knowledge. Moreover, a striking point in the behaviour of thrips is the habit of excreting large quantities of water, which suggests that they are peculiarly fitted to deal with large quantities of dilute food material, extracting the required ingredients and excreting the excess. If a plant is suffering from lack of water, the effect will be to restrict the actual bulk of food to the thrips, which are not likely to increase their rate of multiplication.

Moreover it must be stressed that where two theories can be put forward to explain any particular case, then the theory which can be made to fit every case is probably the correct one. Thus in dealing with the question of thrips incidence on poor soils, it may seem a little far fetched to explain the facts on the basis of temperature, but if temperature will explain every other case as well, and no other theory will, it is probably the correct explanation.

The effect of poor soils therefore in increasing the incidence of thrips, is probably due to the effect of these soils on the temperature of the insect's environment.

PRACTICAL RESULTS.

The practical coffee farmer will probably criticize the whole of the foregoing by saying that it simply shows that the cause of thrips outbreaks is climatic, and beyond his control, and therefore of no practical value. To a certain extent this is true, but practical results may be ob-

tained from it. The only control for thrips, which may appear and devastate a plantation in a few weeks, is spraying. To be effective that spraying must be commenced in time. Any knowledge therefore which renders it possible to foretell an outbreak, or to say whether an outbreak which is commencing is likely to become serious or not, is of the utmost value.

If the theory here put forward, namely that temperature alone is the factor concerned, holds good, then it should be possible to forecast the probabilities of an outbreak at a very early stage. It is known that January, February, March and perhaps April are almost certain to be hot enough to encourage thrips, but that these four hot months alone are insufficient to cause a severe thrips epidemic. Therefore the temperatures recorded during November and December are critical.

If the average mean temperature of December, and still more if these temperatures in November and December, exceed the normal, then there is every probability of a thrips epidemic, and the farmer should be ready to commence spraying in January. Such spraying should be regarded as a reasonable insurance policy; if the unlikely happens, and January or February is cold, then the expenditure is wasted; otherwise a severe infestation may be expected which will probably commence in February or March, depending upon whether October was hot or not.

On the other hand if December, or better still November and December, is cold, then there will be very little likelihood of a serious thrips outbreak, and no preparations need be made for spraying.

Further, a lesson which several farmers learned in February 1935, no regard should be paid in this respect to rain, unless it is accompanied by cold weather. The spraying programme should still be carried out, since as long as the weather remains hot, the epidemic will develop.

A closer forecast could of course be obtained by a study of the weekly or daily temperatures, rather than the monthly temperatures, during the last few months of the year.

Lastly the theory suggests ways of rendering the coffee trees less susceptible to thrips attack, by avoiding unnecessary windbreaks, by wider spacing where there is competition for soil moisture, and by improving water conservation in the soil by every possible means.

Finally it should again be stressed that the actual meteorological data in this paper are those from the Scott Agricultural Laboratories, where no thrips outbreak took place, so the temperatures given cannot be directly applied, but serve merely as a guide to conditions over the whole area. Thus the critical temperature given in these figures is 65° F., the actual critical temperature for thrips is probably a degree or two higher than this. In the present state of our knowledge it is not possible to be more exact.

Summary and Conclusions.

(1) Thrips epidemics have in the past been regarded as being correlated with drought. This correlation is questioned.

(2) An examination of climatic conditions recorded at the Scott Laboratories and the incidence of thrips during the years 1932 to 1935 shows that a close correlation can be found between average mean monthly temperatures and thrips outbreaks.

(3) When the average mean monthly temperature at this station exceeded 65° F. for four successive months, a

slight infestation occurred in the coffee of the Central Province. In 1934-35, when this figure was exceeded for six successive months, a severe infestation occurred.

(4) No direct correlation can be found between thrips incidence and either atmospheric humidity or rainfall.

(5) A direct correlation is found between the disappearance of thrips infestation and a drop in mean temperatures.

(6) Local conditions which increase the severity of thrips can be explained as the results of such conditions on temperature.

(7) As a result of this correlation, it is claimed to be possible to foretell the chances of a severe thrips infestation as early as December, and thus to prevent it by spraying in the very early stages.

Note.—Spraying for Thrips.—The spray recommended by the Department for the control of thrips is lime sulphur, at a concentration which gives a density of 1° Baume. (Specific gravity, 1.007). Details of the preparation of this spray are given in an Entomological Leaflet, obtainable free from the Department of Agriculture.

ACKNOWLEDGMENT.

I wish to record my thanks to Mr. J. A. Bockett, Manager of Nyacthaini Estate, Kiambu, for his reports on the course of a thrips outbreak, and for taking the records from which Fig. 7 was made.

An Equine Pregnancy Diagnosis Service

By JAMES ANDERSON, *B.Sc., Ph.D., M.R.C.V.S., Experimental Station, Naivasha, Kenya Colony.*

Following upon the establishment of the Zondek-Ascheim test for human pregnancy, investigations were extended to animals, and in 1930 some preliminary work of this nature was commenced at the Institute of Animal Genetics, Edinburgh, with Shetland ponies. It was soon apparent that a biological test for the diagnosis of pregnancy in the mare was a definite possibility, and the investigation was extended to all classes of equines. A routine test was devised, and after one year's experience of the method it was shown that pregnancy could be diagnosed biologically in the mare with an accuracy of practically 99 per cent. An Equine Pregnancy Diagnosis Station was accordingly set up, and this station is running successfully to-day.

Judging from the support given by prominent horse-breeders in Britain, both in the preliminary stages when the test was still experimental and now when it is a recognized means of determining pregnancy, the Equine Pregnancy Diagnosis Station is of definite service.

The clinical recognition of pregnancy in the mare is very often a matter of some difficulty. The cessation of oestrus after mating cannot by itself be regarded as an indication of pregnancy, though it is highly suggestive, for experience has shown that oestrus is inhibited in a considerable number of cases following unsuccessful service. Also, it is known that some thoroughbred mares may show only one oestrous period in a breeding season, and the absence of heat cannot therefore be taken as definite evidence of conception. On the other hand, some mares, although pregnant, may exhibit one or more heat periods, and may even be served. It is thus apparent that knowledge of the sexual behaviour of a mare does not afford a reliable criterion of the existence of pregnancy.

Vaginal and rectal examination of the mare, unless performed by a thoroughly experienced practitioner, does not lead to definite information until about the third month of pregnancy, at the earliest. Sometimes it happens that a mare is, in error, thought to be pregnant and is prevented from working and is treated as though this were actually the case. Likewise, it sometimes happens that a mare may show little or no signs of pregnancy until the period of gestation is well advanced, perhaps not until a few weeks before parturition, and is consequently thought to be barren. Mares may be brought to a breeding farm for service and may be left there until in foal. The recognition of pregnancy at an early date would mean that such mares could be sent home sooner than usually happens. When a brood mare is sold it is frequently stated that she has been served on a certain date by a particular stallion and that she is believed to be in foal. If, on such occasions, it could be positively stated that the mare is in foal her value would be greatly enhanced.

With cases of sterility it is an important matter that a sterile animal should be recognized as soon as possible, for the longer the particular sterilizing condition remains untreated the more permanent and serious are the effects likely to be. Moreover, for horse breeders, if it were known that a mare had failed to conceive within a reasonable period after service, steps could be taken to treat the

condition and the possibility of missing a breeding season might be avoided.

It is obvious that the advantages that would accrue from a reliable test for pregnancy in the mare are considerable. Such a test may save the mare hardship and the horse breeder expense and inconvenience.

The essential points about a test for pregnancy are: (*a*) it must be applicable in the early stages of pregnancy before a clinical diagnosis is possible, and (*b*) the technique of the test must be such that the test can be carried out easily, rapidly and as cheaply as possible. The equine pregnancy diagnosis test about to be described fulfils these conditions.

Pregnancy diagnosis tests are based on the presence in the blood or urine of some substance, which in the non-pregnant animal is either absent or is present in very small amount, compared with the pregnant animal. In the mare the test is based on the presence of oestrin in the urine. Oestrin is one of a number of chemical substances produced in the body by the endocrine glands, such as the thyroid, pituitary, ovary, etc. Oestrin itself is produced by the ovary, and possibly also by the placenta. During pregnancy it is secreted in such large amounts that the body cannot use it all, and the excess is got rid of in the urine. It begins to appear in the urine in readily recognizable amounts about the 42nd day of pregnancy, and from then onwards the concentration increases steadily, reaching a maximum towards the end of pregnancy of approximately 200,000 m.u. per litre of urine. In the non-pregnant mare, amounts of approximately 800 m.u. per litre of urine have been found during oestrus and in nymphomaniac mares.

The test employed for the diagnosis of equine pregnancy is a biological one, i.e. the urine is injected into animals; in this case mice being used. In order that the theory of the test may be understood a brief account of the cyclical changes in the genital tract of the female mouse and of the effect of the injection of the oestrus-inducing hormone upon the vagina of the mouse is given here.

The female mouse, in the absence of pregnancy, experiences oestrus at intervals of approximately five days. The maintenance of the oestrous cycle is dependent upon the presence of the ovary, for removal of the ovary prevents the occurrence of oestrus. The ovary, under stimulus of the anterior pituitary, produces the oestrus-inducing hormone, which is known as "oestrin", and it is this hormone which is responsible for the state of oestrus. Absence of oestrus in ovariectomized mice is due to the removal of the oestrus-inducing hormone.

During the oestrous cycle, certain well defined changes occur in the genital tract. In dioestrus in the mouse the uterus, which is in a state of quiescence, is small and constricted. In the next stage, known as "prooestrus", the uterus begins to increase in size, and at oestrus it may be twice its dioestrous size. During the next stage, the distension gradually subsides, and the uterus returns to its dioestrous size and remains in this state until the next prooestrus. The changes in the vagina parallel those in the uterus and are of the greatest assistance in the recognition of the stages of the oestrous cycle and also for the detection of oestrin in injected substances which is done in ovariectomized animals. During dioestrus the vaginal cell content consists of nucleated epithelial cells and leucocytes. The leucocytes gradually disappear, and in prooestrus the only cells found are nucleated epithelial cells. Towards the end of prooestrus a new type of cell,

which is non-nucleated and has a crystalline appearance, begins to occur, and these "cornified" cells, as they are called, gradually replace the nucleated cells until at oestrus they are the only cells present. This is the stage of heat, and it is during this stage that copulation occurs. After oestrus the return of the vagina to the dioestrous state is heralded by the appearance of leucocytes. Nucleated epithelial cells then appear, and the vagina resumes its dioestrous condition. This is the picture of what occurs in the normal intact female mouse, but the same cycle of events can be produced in a mouse whose ovaries have been removed, by the injection of the oestrus-inducing hormone, and this is what is done in the equine pregnancy diagnosis test.

Since the ovary of the mouse produces oestrin it is necessary to remove the ovaries of all mice used for the test. Only ovariectomized mice are therefore used. The vagina of these mice does not undergo any cyclical changes; it remains in the dioestrous state. It therefore follows that any change in the type of cell found in the vagina following the injection of urine must be due to the presence of oestrin in the urine.

The normal urine of the mare is very often toxic to mice, so prior to injection it is treated with sulpho-salicylic acid to destroy any toxic effect. Five mice are used for each test; they receive six injections of graded doses of urine over three days. On the morning of the fifth day, vaginal smears are made, stained and examined microscopically. The test thus takes 96 hours to complete. If oestrin is present in the injected urine, cornified cells will be found in the smear; if it is absent, the smear will consist of nucleated epithelial cells. With appropriate doses of urine the finding of cornified epithelial cells is regarded as positive evidence of pregnancy, and if only nucleated epithelial cells and leucocytes are found the mare, subject to the period of pregnancy at which the specimen of urine is obtained, is known to be non-pregnant.

It has been mentioned that a number of mares are served and apparently hold to service in that there is no recurrence of oestrus, although they have not conceived. Such mares may excrete oestrin in the urine in small quantities; oestrin, as has already been pointed out, is excreted in the urine of oestrous and nymphomaniac mares. It is therefore necessary that the urine should show a concentration of oestrin greater than that found in the non-pregnant mare before a diagnosis of pregnancy can be made.

The minimum diagnostic concentration of oestrin, namely, 1,000 m.u. per litre of urine, occurs about the 60-65th day of pregnancy. A negative reaction, i.e. absence of oestrin from the urine, previous to this stage is of limited value, since the mare may be non-pregnant or she may be slow in elaborating oestrin. After this stage, however, a negative reaction can be taken as definite evidence that the mare is not in foal. The demonstration of 800 m.u. of oestrin per litre of urine, or of smaller amounts, is regarded as a doubtful reaction, for the reasons already given, although it is suggestive of pregnancy. In such cases it is customary to ask for a further specimen of urine to be submitted in a week or two's time, when a definite diagnosis can usually be made. As the duration of pregnancy increases, the accuracy of the test can be enhanced by demonstrating a concentration of urine greater than the minimum diagnostic concentration.

Several hundred specimens of urine from pregnant and non-pregnant mares have now been examined with an accuracy of over 99 per cent. The test is

applicable from the 42nd day of pregnancy, although in the great majority of cases a definite diagnosis cannot be given until about the 60th day after conception.

American workers have developed a test which depends on the presence in the blood of pregnant mares of an anterior pituitary hormone. This hormone appears in the blood at the 42nd day after conception. It is possible by this test to obtain a definite result at a slightly earlier date than with the urine test, but it has certain disadvantages, which are not outweighed by the somewhat earlier results obtainable. In the first place, collection of blood from a pregnant mare must be done by a veterinarian, whereas it is a simple matter for the owner to obtain a specimen of urine. Moreover, horse breeders naturally have strong objections to taking blood samples from valuable, highly strung brood mares for fear of ill-consequences. Taking everything into consideration, the urine test, with its high degree of accuracy and its minimum of interference with the mare, has definite advantages.

The author has carried out a number of pregnancy diagnosis tests in Kenya in the last few years, but it is felt that if it had been more widely known that facilities exist for this test greater use would have been made of it by horse breeders in East Africa.

An Equine Pregnancy Diagnosis Service has accordingly been set up at the Experimental Station, Naivasha, and the test will be carried out there in future. Any horse breeder wishing to have an equine pregnancy diagnosis test made should write to the Veterinary Research Officer, Experimental Station, Naivasha, for full particulars before submitting specimens of urine for test. On application to the Veterinary Research Officer, instructions for the collection of urine, a specimen bottle for the urine, and a form for entering the necessary particulars about the breeding history of the mare will be sent. A charge of Sh. 7/50 is made per specimen of urine. In those cases in which a doubtful reaction is obtained, a second specimen of urine is examined free of charge.

The Scott Agricultural Laboratories, Nairobi

Historical.

The original buildings which formed the nucleus of the Scott Agricultural Laboratories were opened on 7th June, 1913, by Mr. C. C. Bowring, C.M.G. (afterwards Sir Charles Bowring) as a sanatorium. The institution was named in honour of the late Dr. Henry Scott, of the Church of Scotland Mission, Kikuyu. After a period of usefulness as a hospital during the Great War, insufficient support was forthcoming to justify its continued use as a sanatorium, and so, with ten acres of land, it was handed over to Government by the late Sir Northrup McMillan, for public purposes. In 1922, on the closing down of the Kabete Experimental Farm, the property, with a small additional area of land, was set aside for the use of the Agricultural Department, the buildings being converted into laboratories and renamed the Scott Agricultural Laboratories.

Towards the end of 1922 and during the early part of 1923, the Entomologist, Plant Breeder and Agricultural Supervisor from Kabete and the Mycologist from his laboratory on Ainsworth Hill, Nairobi, transferred their headquarters to the Scott Agricultural Laboratories. The staff was augmented on 1st January, 1924, by the addition of a chemical officer, who was transferred from the Department of Chemical Research on its abolition about that time. In 1927 the headquarters of the Plant Breeding Section were removed to Njoro, although an important sub-station of the section has continued to be maintained at the laboratories. The Coffee Section, whose headquarters had previously been in head office, transferred to the laboratories in 1934.

The work of training native agricultural apprentices, which was begun at the Kabete Experimental Farm, was continued at the Scott Agricultural Laboratories, where a native agricultural school has now for some years been an important feature.

When the laboratories were taken over in 1922 none of the adjoining land was under cultivation, except small patches in native occupation. In the following year, however, thirty acres were cleared to provide plots for the experimental work of the various sections, demonstrations of agricultural methods, seed multiplication, and so forth. Further land has been acquired from time to time until the present area belonging to the laboratories is just over 73 acres, of which approximately 24 are devoted to coffee investigations and 44 are occupied by cereals, leguminous and other crops, grass plots, paddocks, buildings and roads, while the remainder, about six acres, forms a smallholding where farming methods suitable for natives are demonstrated. All agricultural operations as well as the running of the native agricultural school are in charge of an agricultural officer.

Functions of the Laboratories.

The main function of the Scott Agricultural Laboratories may be defined as—

(*a*) the elucidation of agricultural problems by means of research and experiment;

(*b*) the provision of technical advice, and the demonstration of special agricultural methods; and

(*c*) the training of natives in agriculture.

How these functions are carried out will be seen from the summaries of the activities of the various sections and their outstations which follow.

Entomological Section.

The staff of the section consists of three entomologists, one of whom, however, having been awarded a Commonwealth Research Fellowship, is absent in America.

One entomologist is mainly concerned with advisory and administrative work. The latter includes the control of plant importation by means of a permit system and the direction of inspection services for which a staff of five plant inspectors is nominally maintained. In practice, however, these officers are employed principally on special duties required in connection with the investigational work of the different sections.

The chief entomological research work at present in progress is on pests of coffee and maize, and fruit-fly investigations.

At the Scott Agricultural Laboratories attention is particularly directed to the control of the common coffee mealy bug [*Pseudococcus kenyae* n. sp. (*P. lilacinus*)]. The section has concluded that the most likely solution of the mealy-bug problem is by biological control through the introduction of parasites, and to this end three lines of action are being followed. Firstly, any readily available parasites of mealy bug other than *P. kenyae* are introduced in the hope that they may adapt themselves to the latter. Secondly, through the collaboration of the Entomologist, Tanganyika Territory, a search for parasites is in progress in Bukoba, where *P. lilacinus* is known to exist. Thirdly, a search for the original home of this mealy bug and its natural parasites is being planned. In connection with the foregoing, an investigation of the climatic requirements of the pest is in progress.

Other lines of work include the biological testing of the toxicity of pyrethrum samples, and an investigation of the factors affecting outbreaks of Thrips (*Diarthrothrips coffeae*).

At the Kasarini Station, near Nairobi, under the management of a plant inspector, climatology and parasitology in relation to Antestia (*Antestia lineaticollis*) and Lygus (*Lygus simonyi*) are being studied. A search for the indigenous host plants of Antestia is being made.

Botanical Section.

The staff of this section consists of one Senior Mycologist, one Mycologist, one Agricultural Officer in charge of Grassland Improvement, and one junior laboratory assistant.

The Senior Mycologist deals with the administrative work of the section and conducts a considerable amount of advisory correspondence on botanical and mycological matters. He is also in charge of coffee berry disease (*Colletotrichum coffeanum* var.) investigations, which are principally carried on at a coffee berry disease experimental station in Sotik, managed by a plant inspector. At the Scott Agricultural Laboratories the chief mycological work is connected with wheat stem rust. The four physiologic forms of this rust which occur in Kenya are maintained in culture and are used in testing the degree of resistance of new hybrid selections produced by the Plant Breeding Section, by means of seedling inoculations and artificial epidemics induced in field test plots. Various minor investigations on crop diseases are also always in progress as time and opportunity permit.

The Mycologist, who is kept as free as possible to devote himself to research, is

stationed at an estate on Mount Elgon, where his principal work at present is the investigation of a special form of dieback prevalent in coffee on the mountain slopes. He duplicates to some extent, under Mount Elgon conditions, the berry disease work in progress in Sotik, and he is also investigating the physiologic forms of yellow rust of wheat (*Puccinia glumarum*).

The Agricultural Officer in charge of Grassland Improvement is stationed at the Veterinary Research Laboratories, Kabete, and has experimental plots in different parts of the country. His main activities are concerned with—

(*a*) the determination of herbage species and strains suitable to various areas;

(*b*) the development of intensive grazing methods where possible; and

(*c*) the improvement of large areas of natural pasture by methods of rotational protection.

Chemical Section.

The section is under the charge of a Senior Agricultural Chemist, who has additional staff consisting of one Soil Chemist and two junior laboratory assistants, all of whom are stationed at the Scott Agricultural Laboratories.

The work of the section may be classified under three headings—

(*a*) advisory service;

(*b*) investigational work; and

(*c*) analytical service.

Under the first heading much advice is given on soil management. Full soil analyses are not recommended, but farmers are encouraged to bring representative soil samples to the laboratories, where simple tests can be carried out which enable manurial and cultural requirements to be discussed.

Recently there has been marked increase in the number of inquiries concerning the growing of pyrethrum flowers and essential oil plants and the preparation of their products for marketing.

Of a rather special nature, advice on the possibilities of three irrigation schemes, on the Tana River, Perkerra River, and the Yatta Plateau respectively, has recently been supplied to Government.

Investigational work largely concerns coffee problems, especially those relating to dieback, but research on pyrethrum and essential oils and the conduct of a soil survey of the Colony are also major items in the programme of the section.

Soil work has included investigation into the phosphate status of Kikuyu red loam and the seasonal water and nitrate content with depth of this soil type, which is one of great importance in Kenya. Soil conservation methods are an important part of the experimental work of the section, which also includes investigations on the preparation of compost.

A survey of the limestone resources of the country has been completed.

The Chemical Section provides an analytical service which deals with such materials as soils, manures, insecticides, and agricultural products.

Plant Breeding Section.

As mentioned earlier in this article, the Scott Agricultural Laboratories are regarded for plant breeding purposes as a sub-station of the Plant Breeding Station, Njoro.

At the Laboratories, hybridization and selection work in wheat is carried out with the primary objects of producing varieties suited to the wheat-growing

areas at the lower altitudes where, owing to the shortness of the rainy seasons, quick maturing wheats are essential. They must primarily be resistant to stem rust (*Puccinia graminis*) but not necessarily to yellow rust (*P. glumarum*), as the latter does not occur at the elevations for which the varieties are required. The Scott Agricultural Laboratories possess the great advantage that, owing to the occurrence of two distinct rainy seasons, two successive crops can be grown in a single year, thus enabling the initial multiplication of new varieties to be carried out more rapidly.

Work on maize at the Nairobi station is confined to the improvement by selection, principally for early maturity and resistance to white blight (*Helminthosporium turcicum*) and Fusarium diseases, of a type of white dent maize, called Muratha. This variety is grown by the natives in the neighbouring Kikuyu Reserve and has already been much improved by selection.

Coffee Section.

The Senior Coffee Officer, who is head of the section, has the assistance of one plantation inspector and one field assistant, and the part-time assistance of the Agricultural Officer stationed at the Laboratories.

The work of the section includes considerable advisory correspondence connected with coffee cultivation and the preparation of the crop for the market.

Experimental work is conducted under two systems, namely, on private estates in co-operation with the owners, and at the Scott Agricultural Laboratories.

The co-operative experiments enable observations on such matters as shade, manuring, pruning, mulching, methods of cultivation and effects of spraying to be made under the various conditions of different districts. At the Laboratories, however, experiments can be much more frequently observed and can be designed with a greater assurance of continuity. In general also the facilities available make it possible to measure results more accurately than can often be done on private plantations.

The trial of imported varieties is a conspicuous feature of the work at the Laboratories, but unfortunately space does not permit the establishment of "seed gardens" under conditions which would enable seed in quantity to be produced true to type.

Apart from variety trials, selections from individual trees showing desirable characteristics are being grown. By means of grafting, also, numerous combinations between different species and varieties of coffee have been made and have been planted in the field for observation. Propagation by cuttings has not proved easy, but greater success has been achieved recently by improved methods.

Other experimental work carried out by the section includes comparative yield trials between coffee grown on the multiple and single stem systems respectively, experiments to determine the effect, especially on flowering, of pruning in different months throughout the year, spraying for the control of non-parasitic leaf fall, shade trials with special reference to the effect on yield and liquoring quality of the coffee crop, tests of cover crops in relation to conservation of soil moisture, green manure and mulching experiments, observations on root systems and root growth, and, in conjunction with the Bio-Chemist of the Coffee Board, investigations on fermentation and drying of coffee. Demonstrations of methods of preventing soil erosion in coffee plantations are also in operation.

Native Agricultural School.

The Agricultural Officer who is in charge of all farming operations at the Laboratories also conducts a native agricultural school, which serves an area roughly bounded by lines running north and south through Nakuru and Voi.

The school comprises sixty apprentices who are indentured for a three-year course. The primary school examination of the Education Department is regarded as the entrance qualification, but it has not yet proved possible to insist on this in all cases.

The primary object of the school is to train natives as agricultural instructors for employment by the Agricultural Department and Local Native Councils, but it also serves as a means of imparting instruction to raise the general standard of agriculture in native reserves.

As a practical demonstration of what natives should aim at in their reserves, a smallholding is run in conjunction with the school, where methods of crop rotation and cultural practices, combined with animal husbandry, are taught. The apprentices also carry out all routine operations in connection with the wide range of crops grown on the rest of the land attached to the Laboratories.

J.M.

Essential Oils

By V. A. BECKLEY, *M.C., M.A., Senior Agricultural Chemist, Kenya Colony.*

During the past few years a great deal of interest has been shown in the subject of essential oils, in East Africa generally and particularly in Kenya. As a good deal of work has been done on the subject at the Scott Agricultural Laboratories since the publication of Kenya Dept. of Agric. Bulletin No. 19 of 1931, a series of articles will be published in this Journal embodying the results of the work.

There is a great deal of ignorance among the general public regarding the nature of essential oils and their value. (One optimistic individual confidently expected to secure a profit of £100 per acre per annum from geraniums!) For practical purposes the essential oils may be regarded as the substances that give plants their odours. In almost all cases they are volatile oily liquids that do not mix with water; some are slightly soluble—peppermint and rose, for example. Usually, they are contained in the odoriferous parts of the plant in very small quantities—a fraction of one per cent. Some few carriers of essential oils contain large quantities: cloves may contain up to 20 per cent of oil; the wood of the East African cedar may carry several per cent of oil.

Generally the oil is confined to one part of the plant; in geranium and peppermint the leaves carry the oil, in vetivert it is the roots. Very often the same or a very closely allied oil is carried in more than one part; in lavender and palmarosa the leaves and the inflorescence carry oils so similar that in harvesting there is no separation of flowers from leaf. On the other hand, the oils from various parts may be very dissimilar. The oil from the needles of the East African cedar differs from that of the wood. The cinnamon tree is one of the most striking examples of this variation in oils; bark, fruit, and leaves all carry different oils.

The essential oils are not simple substances, but complex mixtures of a number of compounds, and are liable to vary somewhat according to conditions. As reference will be made to certain of these compounds when the individual oils are discussed, the main groups will be mentioned here. The first group are the terpenes, which are hydrocarbons, i.e. compounds of carbon and hydrogen only. Many of the terpenes are comparatively insoluble in alcohol, and give trouble in the use of certain essential oils. A very important group is that of the alcohols. They are all strongly scented and of great value. Allied to this group is that of the esters, compounds between the alcohols and acids. Many essential oils are more or less valued on their alcohol and ester content. The last group that need be mentioned here is that of the aldehydes. These compounds constitute the greater part of some essential oils.

METHODS OF PREPARATION.

The methods of production of the essential oils are based on their volatility or their solubility in certain solvents. Of all the methods used, only that of steam distillation will be discussed in any detail. The other common methods are interesting, but are difficult to apply and of little applicability in Kenya. The use of volatile solvents involves expensive apparatus and the loss of the costly solvents. There is at present only one product where it may be economic to use

volatile solvents. *Enfleurage*—the absorption of the volatile oil on a pure fat or a pure oil—has so far not been successful in Kenya. It has not been possible to obtain suitable fats or fatty oils; they are all liable to become rancid. Pure medicinal paraffin has been tried, but it has been discovered to be too volatile, evaporating before it can be saturated with scent.

Distillation in steam is the most usual method of winning essential oils. Although the boiling points of the constituents are much above that of water, a proportion of the oil will pass over in steam. The mechanism of the process need not be discussed beyond stating that the more volatile the oil the greater is the proportion carried in the steam. On condensation of the mixed vapours the two liquids are produced. Being immiscible, the one floats on the other; usually the oil floats.

The stills are simply vessels, usually cylindrical, of metal or a suitable wood, provided with a removable top or a manhole for charging, to which is attached a swan-neck, tinned internally, for carrying the mixed vapours to the condenser. The ratio of diameter to height varies between 1 : 1 to 1 : 2; the squat stills being suitable for close packing materials such as sawdust, the taller for the loose packing such as leaves, The stills are provided either with perforated false bottoms or with perforated cages to hold the material for distillation. At the lowest point of the bottom is a drain cork, to drain off water. Near the bottom may be fixed a reflux siphon.

Stills fall into three classes: (*a*) direct fire heated; (*b*) heated by means of a steam coil; (*c*) open steam coil. The first type is the most primitive. In such stills steam is raised by heating over a furnace. It will be appreciated that in the simplest of these stills the fire must be drawn before the spent material can be discharged, also as steam condensing on the material extracts a good deal of soluble substances, which are liable to burn and produce ill-smelling products, it is essential to draw off the water from the bottom after each distillation, and thus the still must be cool, or else there will be a little burning. Such stills are therefore greedy of fuel. The more modern stills have either a charging and discharging manhole or a cage or removable false bottom, which allow of the spent charge being removed while hot. Water can be run into the still through the reflux siphon while the hot water is being drained off, thus obviating the danger of burning. The reflux siphon has a further advantage in that the initial lot of water may be lessened, since, as the water evaporates, the aqueous part of the distillate runs back through the siphon into the still, thus maintaining a constant level.

In the second type, steam is produced in the still from water heated by a closed steam coil. In this type danger of decomposition of extracted materials is considerably reduced. There is also an economy of fuel. Very often this type of heating is combined with the open steam coil. The open steam coil is the most advanced type of still, and suitable for most of the steam distilled oils. Steam from an external boiler is led into the still, and passes straight into the charge. The rate of distillation can readily be maintained at that found to be best, and there is a marked economy of fuel. Some oils, such as peppermint, are fairly soluble in water; others tend to form a suspension. So there can be a marked loss of oil if the distillation is too long. It is possible to recover a great deal of the oil in the water if the aqueous distillate is led into

the still through the reflux siphon and this be boiled by means of a closed steam coil. In a series of experiments at the Scott Agricultural Laboratories on peppermint, distillation with the open coil alone gave a yield of 0.45 per cent; distilled with the open coil, and closed coil boiling the returned aqueous distillate, cohobation, the yield was increased to 0.55 per cent—an important increase.

The condensers used are either of the coiled tube, "worm" type, or the tubular. Simply, both are tubes, through which the vapour passes, coated by water. The "worm" type is a long tube, tinned internally or made of tin, immersed in a tank into which cold water flows at the bottom and from which hot water flows at the top. The tubular consists of a number of straight tinned tubes, through which, or around which, the vapour passes, cooled by water. Here again, cold water enters at the bottom and hot water leaves at the top. Both have advantages and disadvantages. The tubular condenser occupies less space than the "worm"; it is more efficient, i.e. it will condense more steam to a cool outflow than the "worm" with the same supply of water; it is less liable than the worm condenser to collapse when over cooled. On the contrary, owing to the steam impinging directly on the tinned surfaces, there is a fairly rapid loss of tin and the exposure of bare copper, which will tinge many oils green. While this colour does not spoil the quality of an oil, a change in colour from a pale yellow to a bright emerald green will prejudice buyers against it.

The distillate of oil and water runs into a receiver which separates the oil from the water. For oils lighter than water a "Florentine" receiver is the most suitable. This is simply a "coned" metal can, tinned inside, the wider portion of the cone at the bottom. Near the bottom is an "S"-shaped outlet pipe, the top of the "S" being a short distance below the top of the vessel. Before use, the receiver is filled with water. As the oil-water mixture runs in from the condenser, the oil rises to the surface, while the water escapes through the outlet pipe. The conical shape is given to reduce the rate of downward flow of water as it approaches the outlet, and so allow droplets of oil carried down to rise. In practice, however, a fair amount of oil gets carried over, so two or more receivers in series are often used. With oils heavier than water the distillate should pass to the bottom of the receiver and the water outlet be placed at the top.

From the receiver, after most of the water has been drawn off, the mixture of oil and water is run into a separating funnel—simply a glass cylinder or cone or a tinned metal cone with a sight window, provided with a stopcock at the bottom. When the oil and water have separated from each other, the lower layer is run off, as cleanly as possible, through the stopcock. There is still some water held in the oil. This is removed almost completely by filtration through good quality filter paper, such as Whatman No. 1. Final traces of water are removed by absorption by anhydrous sodium sulphate.

The filtered oils are stored in tinned storage tanks, which are provided with a cock a little way from the bottom. In these tanks the final dehydration is done. The finely powdered sodium sulphate is strewn thinly over the surface of the oil. As it sinks slowly through the oil, it absorbs any water suspended in the oil, and collects in the space below the tap. The dry oil is now ready for export, for

(*Continued on page* 308)

Erosion in the Empire*

By G. C. WATSON.

To-day millions of acres of the Imperial domain all over the world are in danger of destruction by the uncontrolled forces of erosion. In many parts huge areas are losing their original fertility; in others, immense tracts of once valuable land have already reverted to desert, while many more are "on the way". If such basic sources of the Empire's wealth are to be maintained it is evident that more effective anti-erosion schemes must be instituted.

If you speak of erosion nine people out of ten wonder what you are talking about. The other one, if he happens to be a farmer, will probably admit that "something should be done about it," but that it is a subject which mainly concerns the "Government". This, of course, is a fallacy. It is the concern of all. Every patriotic person who has a thought for the Empire's future should be interested in the problem of checking erosion and preserving the land for future generations.

There is no more insidious enemy than erosion. Its work is incessant and often unseen. We are scarcely aware of its far-reaching activities until some serious catastrophe demands public attention.

Not many years ago the Mississippi floods caused widespread damage and distress. "Old Devil River" had overflowed his banks to a far greater extent than usual. Again, quite recently, we hear of townspeople and farmers along the banks of this great waterway having to flee for their lives from the rising flood. About the same time news comes of a dust-storm in Western Kansas, "denser than any yet experienced".

These catastrophes, and other similar ones, it is realized, are almost directly due to erosion. They should be regarded as timely warnings of what may happen if their incidence is not checked by applying control measures.

At one time nearly half the watershed area of the Mississippi consisted of forest land. Now, owing to the enormous demand for wood pulp for newsprint (and for other purposes) this forest area has been reduced by about one-half. President Roosevelt, we hear, is allocating the sum of two hundred millions entirely to the work of combating erosion in the United States; is not this an indication that more might well be spent in many parts of the Empire in checking the same evil?

Let us now glance at some of the "danger spots" of erosion within the Empire. South Africa, of all Empire countries, has perhaps suffered most for want of effective anti-erosion measures. Here, Nature is not so kind as in northern latitudes like Canada where a protective "blanket" of snow is provided during winter months. Moreover, the relentless rays of a sub-tropical sun beat down through the rarified atmosphere of her plateau with withering effect. Floods and droughts alternate at all seasons of the year, taking their toll of life and property, almost as a matter of course. Her gold in some measure may compensate; but it can never pay for the permanent loss by erosion of huge tracts of her arable land. Here, as with the Mississippi, the wooded catchment areas of many of her big rivers have suffered neglect, and many and extensive have been the re-

* Extract from *Journal of the Royal Empire Society*, October, 1935.

sultant evils. Of this the Orange River provides one example. This river alone, within living memory, has carried into the sea sufficient fertile soil to produce crops which would feed the whole of the sub-continent. The same may truly be said of the Zambesi, the Limpopo, and other South African rivers. Owing to the severe losses in the past, vigorous anti-erosion schemes are now on foot, especially for the preservation of forest areas, and particularly of Basutoland, whose wooded mountains give rise to this magnificent river.

In Australia we have many other examples of incalculable loss from erosion—the Murray River affords one. Although its annual flow has remained constant for 50 years, the summer flow has been reduced by nearly one-half (from 49 to 26 per cent). This, again, is directly due to deforestation of the watershed. In consequence, the enormous expenditure (running into millions) on dams and irrigation works has largely been rendered futile. During the course of eight years the storing capacity of the Burrinjack Dam, for instance, in New South Wales, has been reduced by 12,000,000 cubic feet—due entirely to the deposit of half-a-million tons of silt during that period.

But the evil does not end here. Forest lands act as purifiers and filters for the water supply of towns. Many cases are on record, not only in Australia, where by deforestation drinking water has become polluted; an excess of injurious bacteria and also of saline contents has resulted—much to the detriment of the consumers. The close connection between forest and city life is thus apparent. The latter cannot afford to disregard the natural value of the former.

Forests in Australia, as in other parts of the Empire, have been ruthlessly destroyed mainly to satisfy increasing demands of wood pulp for newspapers. It is on record that for one Australian "daily" four acres of virgin forest were sacrified for each edition.

In Palestine, where soil is a precious commodity, a cloudburst recently carried away millions of tons of rich earth into the Mediterranean. This soil, which represented the accumulated wealth of hundreds of years, supported the growth of vast fruit and vegetable gardens; now nothing remains but a boulder-strewn waste. This disaster is largely due to Turkish maladministration in the past. The goat and the camel are commonly cited as initial offenders in this respect, but the truth is "man the destroyer" is the real culprit because, in grazing his animals he allows them to destroy the earth's vegetal cover.

From Canada also come tales of distress. Immense tracts of farm lands, from various causes, have been deprived of vegetation; droughts and floods defeat the farmers' efforts to make good. What can be the remedy?

Now there are many remedies for the evils of erosion. The most simple and effective include preservation of the soil's natural cover of trees and herbage; in short, by wise and provident methods of agriculture. When the "vegetational balance" is upset there is literally no limit to the chain of evils that result.

The most expensive and (in some cases) the most ineffectual, are those involving the construction of huge dams and weirs with their highly paid staffs of hydro-technical engineers. This method, at any rate in the Union of South Africa, has been condemned by experts as tackling the problem "at the wrong end". The service of the botanist and the forester, they say, should be called before that of the engineer and the stone mason; in

other words, the work of control should commence in watershed areas.

The soundest constructive criticism yet offered advocates the establishment of "geo-botanical" stations. By this means, with efficient organization, the most suitable kinds of vegetation for "holding the soil" could eventually be selected. The sympathetic co-operation of the stock-owner and the herdsman would of course be required; for over-grazing has always been the master key for the door of denudation.

Whilst it is true that erosion is the enemy of mankind, it is also the friend. It destroys, but it also creates. Rivers, for instances, often destroy life and property when they overflow, but at the same time they are depositing the detritus (or silt) which is to form the soil for future vegetation. The amount of erosive destruction by rivers, however, is greater at present than their value as soil producers, more especially in the less civilized parts of the Empire. That is the point. What is required therefore is a system of unified control and reckoning whereby a balance could be estimated and maintained; between the loss of arable lands by deforestation of watershed areas, on the one hand, and the formation of new lands, by desert reclamation, irrigation schemes, etc., on the other.

Now a favourable balance between revenue and expenditure is regarded by most governments as essential to the well-being of any State; yet with regard to erosion, an increasingly adverse balance has accumulated in many countries, almost unheeded until recent times.

Erosion, if uncontrolled, becomes a formidable enemy; and it must be fought on all fronts. While nations sleep, its subtle advance continues unobserved. To arrest its pernicious progress unified control of all available forces must at all costs be established.

It may be asked: How can the ordinary layman help in the scientific control of erosion? The answer is by exercising his right as a voter, and by voting only for those candidates who will undertake to support anti-erosion measures in Parliament.

To deal adequately with so vast a subject as erosion, as it affects the Empire today, would demand much study and many volumes. In these remarks I have attempted merely to outline some of those dangers to which the arable lands, and the water supply, of the Empire are exposed at the present time.

True patriotism demands not only a call to arms to fight human aggression, but to stem the tide of the ever-encroaching forces of erosion. The greatest problem of all facing the Empire to-day is not political, nor racial, nor is it essentially defence by armaments; it is geological, for without arable lands and a good water supply the British Empire would soon cease to exist.

MAN THE DESTROYER.

Every traveller in Asia and Northern Africa is familiar with the remains of what were evidently once great cities, requiring vast supplies of food, situated in districts which are now incapable of feeding more than a few sheep or goats. Mr. Kennedy Shaw has described such finds in his series of articles on "Dead Libya." What is now desert was clearly once fertile country carrying a numerous and highly civilized population. It was thought at one time that the desiccation was the result of climatic charges. . . . The theory is now generally abandoned for the convincing reason that the process can be seen going on to-day as the

plain result of man's own ignorance and lack of foresight in his treatment of the soil by which he lives. In America this rake's progress is particularly rapid, but it is not peculiar to America. . . . In South Africa, in parts of Australia and Canada, and in many other countries with seasonal rainfall it is a very serious menace. Owing to faulty land management valuable agricultural land in French and British Nigeria and in the French Sudan is being conquered and absorbed by the Sahara Desert at a rate estimated to exceed a kilometre a year.—*The Times.*

According to Professor E. P. Stebbing, the Sahara has advanced 300 kilometres southward in three centuries. On this question of soil erosion much of great interest and value may be gleaned from a report (the Clarendon Press, 6s.) by Dr. MacLagan Gorrie, of the Indian Forestry Service, on his four months' survey in the United States on behalf of the Leverhulme Research Fund. He details the abuses of the land in California and elsewhere, and suggests that the proper agency for holding and developing land and preventing such abuses is a small but representative public body with sound technical advice at its disposal, and sufficient powers to enforce its decisions. Private ownership and the common use of "waste" land have almost invariably overworked one use and neglected other possibilities, failing to develop the multiple use principle which can best serve the community as a whole. In the enormous areas of village grazing or common lands in British tropical countries, urgent action is necessary to prevent further misuse and conserve what is left of the soil's natural resources. Such action can obviously not be undertaken by the villagers themselves without some help from Government.

OIL FORMATION IN GROUNDNUT WITH REFERENCE TO QUALITY.

The percentage of oil formed in groundnut seed increases gradually as the seed develops, except in the early stages immediately following fertilization and the period just preceding maturity. As the quantity of oil developed increases, the free fatty acid content diminishes. There is also a decrease in the moisture content of the seed and increase in the shelling percentage as the seed develops. The harvest of the groundnut crop even a week before the kernels are fully mature affects the quality, as it enhances the free fatty acid content and reduces the oil content of the material. The practice of early harvest of groundnut, especially in South India, thus affects its quality, and may stand in the way of foreign demand.—*Indi. J. Agric. Sci.*, 5, 165; Author's abstract.

(*Continued from page* 304)

Essential Oils

which purpose the best containers are fairly stout, tinned iron drums.

The principles of distillation of essential oils are quickly picked up, and the finer points in the technique soon learnt by experience. It is interesting, and the final product has an attractively small bulk—two points which tend to attract people. But before anyone embarks in any scale on the production he should consider the whole subject very carefully. The markets for essential oils are very limited indeed, and any overproduction is immediately followed by a marked drop in price. Unless a high quality product can be uniformly produced, so as to attract the buyers in preference to old established oils, the venture will be a failure. Prices fluctuate enormously and rapidly, according to the demands of the market and the supplies available.

Overstocking in Kenya

II.—Overstocking in Native Reserves and Disposal of Surplus Stock

Considerably more than three-fourths of the total area of the Colony is practically purely pastoral, and it was estimated in 1933 that some 12,000,000 head of stock are carried, of which number approximately 6,000,000 are cattle. It is improbable that more than 30,000 head of cattle reach the Colony's markets in an ordinary year—a negligible number having regard to the vast potential supply. Since there is but little "drain" in that respect, it is reasonable to assume that saturation point has been reached with regard to grazing, and that the only limiting factor is mortality due to drought and disease. In addition, the enormous game population has to be considered, particularly in the Northern and Southern Game Reserves.

The area under discussion comprises some 100,000,000 acres, undoubtedly an enormous extent of territory, but, considered in relation to the total number of stock carried, there is a proportion of approximately eight acres to one beast, which cannot be considered a generous provision having regard to the large areas of bush-covered country, waterless tracts and fly belts.

The real problem of overstocking, however, is not so apparent, and should not be considered in terms of acres available per beast. The tribesmen are well aware of the most desirable grazing, and it is to the advantage of each owner to graze such places independent of neighbouring *manyattas*. The result is that vegetation is destroyed to the roots, and only the most fibrous herbage is able to persist through such cycles of destruction. This is usually the condition before the rains; there is no vegetative mat to resist the effects of wind and sun and to counteract wash and erosion.

It is impossible to estimate exactly the ulterior influence of overstocking on the stock population. It is, however, certain that stunted growth, slow development, and diminished productive capacity are natural *sequelæ* of a progressive nature. Experiments at animal husbandry training centres have shown that many native cows are capable of a relatively good performance under favourable conditions of management; but it has also been proved that many animals are practically useless from the point of view of milk production and breeding capacity. These latter facts have been particularly demonstrated at the Machakos Centre, and it may be inferred that they are a definite reflection of the condition of the Machakos Native Reserve.

Investigations carried out at Ngong, Baraton, and other animal husbandry training centres clearly indicate that a system of rotational grazing materially improves the carrying capacity of pastures, principally by the retention of perennial and other grasses through seeding, and of the vegetative mat which prevents denudation and erosion.

No policy of de-stocking is likely to be successful until a permanent market is made available, and by a market is meant some form of economic disposal. To cope with this problem the establishment of meat and by-product factories has been considered, but mostly in relation to schemes from the financial point of view, and on the basis of an assumed market

value for native cattle. If, however, it is accepted that overstocking exists, and that there is an urgent necessity to prevent the destruction of grazing and deterioration of stock, it is considered that the establishment of a factory is imperative, and that any financial loss entailed would be more than repaid by the eventual improvement in grazing stock and the immediate stimulation to native trade. Furthermore, such a factory, designed to produce dried meat if required, or easily convertible for the purpose, would be a satisfactory and economic form of assurance against hardship or even starvation in times of drought and famine. It is suggested that at such times a supply of dried meat would be invaluable, as compared with cereals, from the points of view of nutrition, cost, and transport.

If a factory were to be established at some suitable place on the railway line, it is believed that it would be possible to tap all the native reserves of the Colony for supply, and that stock routes could be found and organized, entirely avoiding the settled areas. This, however, is a matter that would require consideration, and would probably involve some expense, particularly in regard to the erection of dips.

Side by side with this development there would be a greater justification for disease control measures and for an extensive castration campaign of native scrub bulls.

It might be that compulsory measures would be necessary to effect these or similar proposals. To sell surplus cattle would be distasteful to the tribes unless prices were very alluring, but it is contended that the main issue is no longer concerned with immediate native welfare; it concerns the generations to follow.

A skeleton veterinary establishment has been provided in all the native pastoral areas with the exception of Turkana Province. Considerable progress has been made in disease control and animal husbandry methods. Work on the latter has not extended far beyond research into the capacity of the various types of native cattle and instruction in the preparation of stock products for marketing. A vast amount of work remains to be carried out in regard to improvement of stock by culling and castration, and by steady propaganda in the field. Such activities, however necessary they may be, cannot profitably be attempted until a market has been established, creating an incentive and an objective.

An Inexpensive Wooden Drag for Use in the Construction of Mangum Broad Base Terraces

By COLIN MAHER, *M.A., Dip. Agric. (Cantab.), A.I.C.T.A., Agricultural Officer, Kenya Colony.*

The use of Mangum broad base terraces for the control of soil erosion on arable land has been described in Bulletin No. 1 of 1935 issued by the Kenya Department of Agriculture.

Admirable implements are obtainable from certain firms which manufacture farm implements which have been designed expressly for use in the construction of contour ridges or terraces. These implements are somewhat costly, however, and many farmers, especially small farmers, possibly may delay carrying out terracing on their lands because they are not in a position to buy the steel terracing implements; meanwhile, soil erosion, unchecked, plays havoc with their lands, and the largest part of the capital of these farmers—the fertility of their soil—dwindles away.

A wooden V-drag has been described in bulletins published by the United States Department of Agriculture; such a drag, with certain additions, has been found to be of great use in Kenya, and can be made for a few pounds, either by the local blacksmith or by the farmer himself, if he is a "handy man".

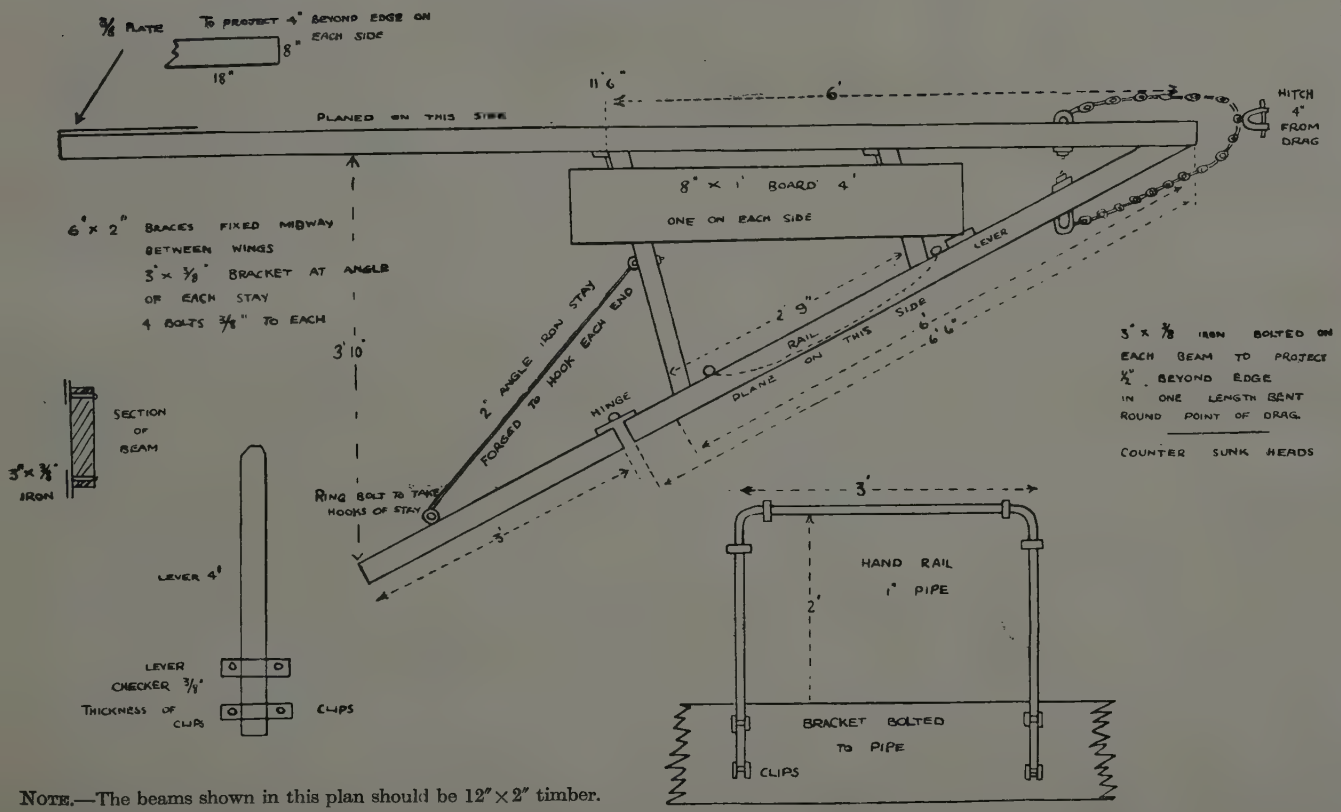
The details of this V-drag are shown in the diagram. The wood used must be hard, well-seasoned timber. It will be seen in the diagram that a steel "fishtail", similar to those on "Martin" ditchers, is shown at the end of the long straight edge of the drag; this is an elaboration which may be omitted if desired. The implement is heavy, requiring a full team of oxen to pull it, and better work will be done if the oxen are used only in short shifts. A small boy is required to lead the oxen, and it may be advisable to employ two drivers, one boy being specially responsible for the hindermost oxen. Two boys should be placed on the drag to keep it to the work, and these boys, by altering the disposition of their weight to one side or the other, can, to some extent, steer the drag as required; for the rest, steering is dependent on the driving of the oxen.

The hand rail and lever can be removed and inserted on the other side if it is wished to reverse the drag. The soil collected by the short arm, or "share", of the drag may be dropped so as to form a sloping bank by tilting the drag. This is accomplished by the boys weighing heavily on the long arm or "landside" of the drag and hanging backwards over the unploughed land, preserving their balance by pulling on the lever and hand rail.

When the land has been pegged out at 50-foot intervals, as described in Bulletin No. 1 of 1935, the land is ploughed along the line of pegs, returning along the same line and through the second furrow towards the first to form a ridge. Experience will decide whether, with the plough which is being used, it is better to make one or two trips with the plough before starting to use the drag. Probably it will be found best to use the drag, up and down each side of the ridge, without the extension to the short arm for the first trip, subsequently fixing the extension.

The terrace is now ploughed and dragged alternately, keeping the long arm of the drag close up against the side

V · TERRACE DRAG



NOTE.—The beams shown in this plan should be 12" × 2" timber.

of the furrow, till the terrace is about two feet high and of sufficient width. The completed terrace should be at least twenty feet wide, but in the first year it may be found sufficient work to complete terraces which are about fifteen feet wide.

Weak places may be strengthened or high places excavated by means of a dam scoop. Care must be taken to ensure that the upper channel is wide enough and is not left as an abrupt ditch; further, it must be secured that there is no channel left *below* the terrace which may fill with water and then overflow, thus producing gullies below the terrace. It will be found advisable to do the last dragging on the top side of the terrace, reversing the drag at the end of the terrace for the return trip. In order to avoid sudden turns in the terrace banks and, consequently, difficulty in ploughing the land between the ridges in after years, it is necessary to smooth out the curves of the terrace line. The terrace bank must be raised at any deviations *below* the original pegged line; the terrace ditch must be deepened to give the correct grade if the line is taken *above* the pegged line. Ploughing of terraced land must be carried out round and round between any two banks, starting on the tops of the banks. The finishing furrow in between two ridges must be harrowed level as far as this is possible.

The Organization of Native Arabica Coffee Cultivation in Bugishu

By A. J. KERR, *Agricultural Officer, Uganda.*

Arabica coffee-growing in the Bugishu District of Uganda Protectorate dates from 1912, and it has already grown into an industry of considerable dimensions. The accelerating speed of development can be gauged by the fact that the crop in 1915 was 11 tons parchment, in 1925 about 50 tons, rising to 260 tons in 1930. The estimated crop for 1935 is 2,000 tons of parchment, and planting up continues at the rate of about 1,000 acres a year.

The area in Bugishu suitable for Arabica coffee-growing is a belt on the slopes and amongst the foothills of Mount Elgon, extending from an altitude of about 4,200 ft. to 7,500 ft. on the southern and western sides. The belt is about 30 to 40 miles long, and varying in width up to about 10 miles. It is divided into four rough topographic areas, South Bugishu, Central Bugishu, North Bugishu, and North Bugishu Hills together with Sebei, though from a coffee-growing point of view a simpler differentiation is made in "Low Elevations" (between 4,200 ft. and 5,500 ft.) and "High Elevations" (between 5,500 ft. and 7,500 ft.). At the low elevations rainfall is about 50 in. a year, and there is a pronounced dry season from mid-December to mid-March. At high elevations effective rainfall is greater, the dry season is less severe, soil is more suitable, and conditions are generally more favourable to coffee.

Before proceeding to describe the detailed organization of native coffee cultivation in Bugishu, a short account of various factors bearing on the somewhat specialized organization will be given.

Until the introduction of coffee, the Bagishu inhabiting the coffee belt were without a cash crop, and worked as porters on Buganda and Kenya plantations in order to earn sufficient money to pay their poll tax.

Steps were taken to foster the new industry, and, with falling prices, demand for labour decreased, so that coffee-growing received a natural encouragement. Once the cash value of the crop was realized by natives, planting extended rapidly.

The native method of raising and transplanting seedlings left much to be desired; there was a tendency amongst certain natives to plant up a larger acreage than they could properly tend, and porters returning from Buganda often brought back with them Robusta and other types of seed. Spacing, general cultivation, pruning and preparation of the crop for sale were little understood.

Though the Bagishu are rather a primitive tribe, the social organization is well developed. There are Saza chiefs, Gombolola chiefs, and minor chiefs, each having varying responsibilities, and these administrative units have been used in the development of coffee-growing. In the first place, trained agricultural assistants were sent out to give instruction in the growing and preparation of coffee, nurseries were established, and hand pulpers purchased by Government for use by natives free of charge. By 1927, marketing difficulties began to arise. The system of marketing native-prepared parchment through numerous licensed Indian and native buyers, working for a few larger firms, produced a bulk of uneven grade. Buying by weight on a commission basis encouraged the sale of

improperly dried parchment, which deteriorated further in bulk. Various cultural difficulties had arisen, besides, and in 1930 a full-time agricultural officer was stationed in Bugishu.

The acreage in bearing for the 1935-36 season, that is, planted to the end of 1933, is about 3,500, and under present conditions, with a population of about 26,000 taxpayers in the coffee belt, potential coffee acreage is estimated at about 10,000. From these figures it will be seen that the average size of a peasant holding allowed for is only slightly more than one-third of an acre. A holding of this size can be easily maintained under first-class cultivation, and produces a crop of over 500 lb. parchment, on the basis of average district yields over a period of several years, which is sufficient to pay poll tax and give a handsome margin. If anything, as progress is made, the average size of a peasant holding will tend to increase, but at the present stage great care is necessary to limit plantings according to individual circumstances.

Instead of allowing therefore saturation point with regard to planting to be attained in a haphazard way, the work is being spread out over a period of years. Planting is controlled by Government. The general system adopted is that seed is prepared at a Government maintained plantation for issue to four Government central coffee nurseries, each serving an area comprising several administrative units (gombololas). From these four nurseries, seedlings in the cotyledon stage are transplanted into gombolola nurseries maintained by the native administration, prior to distribution to natives. No privately maintained nurseries are allowed.

In this way, each gombolola may have from 30 to 100 nursery beds, each 63 ft. long by 4 ft. wide, and capable of holding 1,000 plants at 6 in. x 6 in. spacing. A date for transplanting is arranged, each porter being made responsible for fetching and transplanting 500 seedlings.

In order to ensure that the two transplantings take place under optimum weather conditions, it is necessary to hold over seed from the crop ripening in October-November for planting in central nurseries until the rains in the following April and May. The young seedlings are then ready for transplanting into gombolola nurseries with the short rains, and for distribution to natives with the following rains at the age of eleven or twelve months.

Prior to distribution to natives, the chiefs, with the assistance of the local agricultural instructor, select applicants capable of tending additional coffee. Old cultivators are allowed a free issue up to 50 trees only, new cultivators up to 100, any in excess being paid for at the rate of 10 cents per tree. This selection is done in time to allow of preparation of new plots (including digging holes large enough to hold a four-gallon petrol *debi* at the recommended spacing), and inspection, before distribution takes place.

As the chief is responsible for his own area, the method gives him a lever to maintain efficient cultivation.

Distribution is carried out under the agricultural officer's supervision on a specified day, gradual removal of shade from nurseries having previously been carried out. The plants are pulled up by hand and laid in two rows on the bed for inspection and culling of plants with twisted taproots. They are collected in lots of ten by porters, and made up to the required count in such a way that distribution keeps pace with uprooting. If the recipients are properly organized according to sub-chiefs' lists, 100,000 plants can be distributed in a day. A

demonstration on these occasions is of value to stress the importance of good planting.

As to general cultivation, a spacing of 8 ft. x 8 ft. was first adopted, clean weeding was practised fairly widely, and the single stem pruning system recommended. An attempt was made to teach the latter, but individuals did not become proficient, and the trees at low elevations deteriorated. Following a very heavy crop in 1930, trees at low elevations suffered badly from die-back, and it was decided to allow all these single stem trees unlimited terminal growth as a temporary expedient, and to adopt a multiple stem system of pruning, modified for native conditions, for new plantings. The nursery system allowed of plants being distributed as multiple stem trees after topping in the nurseries. At high elevations the single stem system was retained. Mulching with banana leaves was encouraged and spacing reduced to 6 ft. x 6 ft.

In 1927 a Government coffee experiment station was opened at Bugusege, in one of the low elevation coffee areas, to elucidate some of the local problems, such as pruning in relation to native capabilities; cultural treatment, especially cover cropping (in view of the limited supply of banana leaf mulch, the cultivation of coffee on steep slopes, and the native willingness to plant beans for food); close spacing, alternate line stumping, and uprooting, etc.

Observations have also been made on such points as time of stumping, converting single stem trees with unlimited terminal growth to the multiple stem type without loss of crop, single tree yields, whilst watching the effect of various pruning and cultural treatments on grading out-turn, degree of berry borer infestation, etc. Native administration coffee plots were established in each gombolola in 1924 to demonstrate pruning and cultural methods, also to observe the effect of permanent shade and of interspacing with plantains. Having served their purpose they were later sold to natives.

The difficulty of getting native owners to prune their trees properly has been a real one, especially so with single stem trees. With the retention of this system at high elevations, a recent development has been the organization of Pruning Clubs, the general working of which is as follows:

A responsible native is chosen by the agricultural officer as honorary president and treasurer. At present it seems advisable for the gombolola chief to assume these duties, but it is intended that the society itself shall elect its own officers as soon as is practicable and run its own affairs.

Membership entails payment of a sum of 2 cents per tree to be pruned. A simple accounting system is used.

The agricultural officer selects and trains pruners for the club.

They are put on task work in such a way that each pruner's work can be checked and payment is made at the rate of 1 cent per tree properly pruned, a record being kept of the number of trees pruned by each man. At present the gombolola agricultural instructor assists with this work by allocating members' shambas, checking the work of each pruner and recording, on a labour sheet, the number of trees pruned daily. The pruners are paid monthly.

It is hoped that in time the society will be able to run its own affairs, with occasional advice from the Agricultural Department on such points as rates of subscription and pay, the technical side of pruning, etc.

As regards insect pests, berry borer at low elevations is occasionally serious, but parasites are known to exist in the district. It may be possible to control the pest by adopting special cultural methods at low elevations.

Antestia is present in some areas, but not to a serious extent. A survey is being made by the agricultural officer, using kerosene-pyrethrum extract, to gauge the spread and intensity of this pest, in order that control methods may be applied if necessary.

Leaf disease (*Hemileia*) is serious below elevations of 5,300 ft. generally, and is associated with heavy leaf-fall followed by dieback in heavy cropping years. Shade appears to be beneficial in this connection, and could be adopted under the Bugishu organization.

For stem borers, the method of control is by stumping or uprooting and burning, the work being performed by instructors, assisted by communal labour if necessary.

Of various other pests and diseases, none is present to any serious degree.

The inherent quality of Bugishu coffee was known to be good, but the method of preparation and marketing, previously mentioned, left much to be desired. An attempt was made to overcome some of the difficulties by holding markets in 1928 and 1929, but buyers' rings were formed and prices depressed. Eventually, the Bugishu coffee scheme, financed by the native administration, was formed, with the object of dealing with the crop from the cherry stage onwards. A coffee curing factory was erected at Bubulu, and several pulping stations. In 1931, 80 tons of parchment coffee were handled.

At a later date, certain areas were closed under the Native Produce Marketing Ordinance and an exclusive buying licence granted to the Bugishu Coffee Scheme.

There are now twenty-nine pulping stations scattered amongst the coffee-growing areas, some of a permanent and others of a temporary type, at which coffee is purchased from natives on a ticket system. It is pulped, fermented, washed and part-dried, before being transported to drying centres situated at four central points. The present factory is situated to deal with the South Bugishu crop, and as this works it to capacity, that from the remaining areas is despatched direct from drying centres as parchment for cleaning in Kilindini.

A Board, consisting of the District Commissioner, Bugishu; Senior Agricultural Officer, Eastern Province; Agricultural Officer, Bugishu, and two native members, advises the Provincial Commissioner on all matters relating to the Bugishu Coffee Scheme.

There is a manager and two European assistants to supervise work at pulping stations. With the exception of one or two Asiatics, the rest of the staff is native.

A quantity equivalent to 700 tons of parchment was handled by this organization in the 1934-35 season.

In conclusion, although the practical working of the coffee-growing organization in Bugishu leaves room for improvement, the general principles have proved themselves to be sound. Already coffee production in Bugishu bears favourable comparison with average European estate production, and though certain modifications may prove to be necessary, there is every indication that the industry will continue to prosper.

A Note on Cultivation Methods in Light Soils

By COLIN MAHER, *M.A., Dip. Agric. (Cantab.), A.I.C.T.A., Agricultural Officer, Kenya Colony.*

Dr. Vageler, in his book *An Introduction to Tropical Soils*, says: —

"Attention has already been drawn to the fact that, owing to the high density of rainfall in the tropics and subtropics, every slope is likely to receive less than its fair share of water. There is, in addition, grave danger of erosion, which may remove great quantities of the valuable topmost soil in which humus is present. For this reason the first task of good farming is the terracing of all slopes for prevention of water loss and erosion.

"The second consideration of quite general importance is increasing the water-holding capacity of a soil to a maximum by obtaining the highest possible degree of good tilth within the zone of root development. For annual plants this can be done by thorough working of the soil to a good depth, but the method employed must be well suited to the soil in question. Heavy soils as a rule respond very well to deep cultivation in the ordinary sense, i.e. to deep ploughing or cultivation by hand, since this often has a surprisingly big effect in increasing their ability to yield water to the plant although their water-holding capacity is not appreciably impaired. With light soils, on the other hand, this procedure is highly dangerous. Here, in contrast to the clays, the colloidal constituents of the soil, which are not in any case present in large amount, are coagulated by deep cultivation or even destroyed, with the result that a light soil thus treated rapidly loses all power of retaining water. In such cases shallow ploughing or hand-working must be accompanied by simple loosening of the subsoil, so carried out as to avoid carrying down the surface soil to great depths. All operations comprised under the head of dry farming must be judiciously employed so long as the fields are bare of crop."

There is no doubt that farmers on light soils in Kenya have been led away by memories or hearsay of English practice, especially on heavy soils, in the matter of deep ploughing. Constant deep ploughing on light sandy soils, such as those derived from gneisses and schists, has resulted in the loss of the crumb structure of the soil, the acceleration of erosion and the washing out of the valuable soil colloids which retain most of the lime and phosphates reserves of the soil. The deterioration thus caused has been intensified by the fact that ploughing has been carried out for many years in the dry season, during which crumb structure of the soil has been destroyed and humus oxidized, while the soil is often left in a state in which the maximum amount of soil wash may occur with the sudden onset of the long rains.

In maize-growing districts an interplanted crop of a green manure, such as cowpeas, might be planted and left on the soil over the dry weather; or alternatively the weeds which have grown amongst the maize subsequent to the last cultivation, which was given at tasselling time, may be left to shield the soil from the burning sun.

As far as possible, the farmer on light soils, who expects the "long rains" to begin in April, should endeavour to obtain adequate equipment and cattle to enable him to do the greater part of his ploughing in February and March. On some farms the keeping of larger numbers of working oxen will involve the necessity of growing some fodder crops, such as elephant grass (*Pennisetum purpureum*), to assist to feed the oxen.

In order to make the utmost use of the days on which the soil is in a suitable state for ploughing, some farmers adopt the excellent expedient of working the oxen, two teams to one plough, in three-hour shifts. Each plough is then kept working from dawn to dusk, and the labourers and cattle are able to keep up a

good speed with the ploughing, since they are never so fatigued as towards the end of one six-hour shift.

It is recognized that certain of the heavier volcanic loams cannot be ploughed when wet, but in this case early ploughing and the exposure of the heavy soil to dry season weathering is an advantage in some respects. Many farmers on light soils complain that their land very readily becomes too sticky to work and can only be ploughed when dry; this condition has doubtless arisen through the loss of the crumb structure and of the humus of the soil in past years and should be remediable in part by the application of *boma* manure or by green manuring.

Relatively shallow ploughing should be employed on the light soils, together, if possible, with deep cultivation by rigid-tined cultivators. This procedure will enable the soil to be well aerated below without exposing to the sun more soil than need be. It may be found sufficient to use the cultivator only every other year; on the other hand, some farmers have found it feasible to dispense with ploughing for a year and to prepare the seed-bed by cultivators and harrows alone.

Control of Striga Weed in Nyanza Province, Kenya

By W. L. WATT, *Cert. H.A.S. Forestry, Agricultural Officer, Kenya Colony.*

In Nyanza Province of Kenya there are great areas of land in the belt between Lake Victoria, at 3,726 feet, and the contour line slightly over 5,000 feet; within this belt Striga weed (*Striga hermonthica* Benth.) is found in great profusion in a large proportion of the patches of cereal crops grown by the natives.

Before the harvest of the sorghums, which is the most common cereal in the area, expansive stretches of land in the district assume a red glow of colour, due to the presence of this weed.

One may see a certain amount of the weed in the alienated farm land bordering on the Kenya and Uganda Railways and Harbours track, but there, by the aid of the Striga Rules, the weed has been brought well under control.

OUTLOOK.

The natives have known Striga since their infancy, and have ceased to take any interest in its extermination. So deep rooted is the belief that it is impossible to control the weed that even under the Rules the natives submit to punishment in a fatalistic way. If they are found by officials to have the weed in their crops, they only consider that they have been unlucky.

PRESENT CONTROL METHODS.

There are standing orders that the weed must be removed by hand weeding or by scuffling before it sheds its seed, and the chiefs, sub-chiefs, police, and native agricultural instructors are expected to see that these orders are carried out. Large numbers of offenders are fined up to Sh. 25 each during the crop ripening periods.

DAMAGE.

The cost to the Province in actual grain, or in indirect loss through land being put under crop which should have remained in grass for the cattle, is beyond doubt very considerable, and might amount approximately to an average of 1 bag of 200 lb. of grain per family, or about 125,000 bags.

The chief crops affected, in the order in which damage is suffered, are sorghums, finger millet (*Eleusine coracana*), maize, and sugar cane.

PRESENT CROP ROTATIONS.

The infested area is populated by a very large number of tribes living under differing conditions of soil and climate, while transport facilities also vary, so that a divergence of cropping methods is caused. The greater number of natives, however, plant cereals almost continuously on the same land, the only rotation being a resting period under grass and weed. The fallow does not appear to have any hindering effect on the Striga weed, and a very long period would be required before the Striga seed lost viability.

In one of the cotton areas (Marach), the system now worked by many natives is as follows:—

CROP	Planting	Harvesting
Finger Millet ..	Feb. to Mar.	July
Cotton.. ..	July	January
Sorghum ..	March	July-August
Cotton.. ..	July-August	January
Cassava or ..	March	Three years
Sweet Potatoes	—	One year

When sweet potatoes are used the land is under the crop for one year, followed

by the two years' rotation of cereal, cotton, cereal and cassava noted above.

Future Method of Control.

As has already been stated, the natives are stubborn in refusing to accept possibility of complete extermination of the pest, and say, "As a man shaves his chin to-day, so must he shave it again to-morrow." Or, in other words, remove the Striga to-day and it will inevitably grow up again.

The application of the Striga Control Rules is almost impossible when such a huge affected area is in the hands of natives holding these views.

Alternatives have been sought, and a certain advance made.

Plant in Lines.—When the present varieties of sorghum, of which there are a large number, are planted in rows, it is very much easier to weed out the Striga than when the host plants are scattered. Some of the present varieties appear to have a certain amount of resistance, and even when attacked they can produce some crop.

Search for Resistant Strains.—Several plots of Potchefstroom Brown, and small patches of Potchefstroom White, were planted in infested land. It was found that they were susceptible to the extent of producing no crop when attacked.

Early Varieties of Sorghum.—The Potchefstroom varieties, when grown on slightly infested soil, have the advantages of ripening early, and can be harvested before the Striga seed has become dispersed.

There are now the two equally early varieties which are heavy yielders, Kano and Dobbs, which, although not resistant to Striga infestation, can still produce a good crop before the Striga has obtained a firm hold.

Immediately after harvest, the sorghum straw should be slashed over with the Striga, and, if possible, the land turned over at once. By this method there should be little Striga infection in the succeeding year, provided it had not yet set seed.

It is a common practice in the cattle areas, where there is usually a shortage of grazing about harvest time, to allow weeds and grass to become established before the crop is harvested, in which case the weed and plant growth need only be slashed over.

Smother Crops and Weeds.

Considerable control can be attained through the agency of smother crops and weeds, and if the rains are sufficient there is likely to be no depreciation of yield of grain.

In trials the following beans were found to be of little value:—

Njahi (*Dolichos lablab*) had a smothering effect on the grain crop, and should be planted about 2 to 4 weeks later than the cereal; but as a rule the crop is too sparse to be effective.

Dolichos biflorus was tried, and sometimes forms a fairly dense growth, but there is no market for the grain.

The Tepary bean was unsuccessful.

The Canadian Wonder bean formed too sparse a canopy.

Fairly good results were noticed with some annual weeds, but McDonaldi weed (*Galinsoga parviflora*) was found to be best and most excellent for the purpose. It grows very fast and forms a dense soil cover. No Striga weed has yet been found where McDonaldi has had a chance. Although this smother crop cannot be classed as a desirable stock food, it is eaten by cattle.

McDonaldi can be cultivated at least twice in the early stages of the cereal crop and then still form a very dense growth. If cultivation is carried out in alternate rows, or series of rows, this weed will be invaluable as a deterrent to soil removal by storm water.

Kraal Manure.

Where this is used in sufficient quantity on Striga-infested soil it will almost completely control the parasite. There is usually a much more luxuriant annual-weed growth where manure is applied, which does much to smother the Striga weed.

Cassava Planting.

Patches of land which are useless for cereals because of Striga have been partly planted up with Cassava by placing cuttings in the growing cereal at about 3 ft. x 3 ft. or 4 ft. x 4 ft. After the cereal harvest the land is kept clean cultivated for at least one year till the root crop is well established. After that it is sufficient to allow natural grass to cover the surface.

Progressive harvests of the Cassava roots commence about 18 months from the planting of the cuttings and go on till the crop is finished, before the end of the third year. Usually, by the beginning of the third year, the cattle are allowed free access to the grass and Cassava leaves.

When such land is planted up with cereal again there will be no Striga remaining. As far as is known, it is liable to become reinfested in due course through the agency of dirty cereal seed, storm water, whirlwinds, and other means.

Recommendations.

The best control methods are considered to be:—

Uprooting and burning the Striga before it disperses seed.

The use of early maturing varieties of sorghum, finger millet, and maize.

The encouragement of McDonaldi weed.

The manuring of infected land with kraal manure.

The increased cultivation of Cassava throughout the Striga belt, particularly in infested land.

The discouragement of repeated planting of cereals on the same land and the encouragement of a better rotation of crops.

Some Aspects of the Poultry Industry in Kenya

By R. S. BALL, *Dip. Agric. (Cantab.), A.I.C.T.A., Agricultural Officer, Kenya Colony.*

The prevailing low prices for produce have emphasized the desirability of converting them in part into other products before they leave the farm. For this reason, a number of farmers are turning to poultry as a side-line to their other activities. It is probably as a side-line only that the enterprise will prove reasonably profitable, so that the fullest utilization of surplus produce can be made. As a proposition by itself, where all foods have to be bought and transported, there is probably not very much scope in Kenya; for, apart from the difficulties that arise where large numbers are handled, the outlet for poultry products is not at the present time sufficiently great to justify a large expansion on these lines.

While there is a fairly steady demand for eggs, yet the marketing of surplus cockerels and old hens (particularly the latter) is, in up-country districts particularly, a very difficult problem, although in the vicinity of towns there may be a small demand. Therefore the policy should be as far as possible one of egg-production, and the elimination of surplus cockerels at the earliest possible stage should be practised. For this reason, the desirability of sexing day-old birds, a practice which is now adopted on a very large scale in Europe, would be extremely useful in this country. It should be pointed out, however, that the determination of sex by this method is by no means easy, and it requires a great deal of practice before an approach to accurate results can be obtained. The alternatives to the above method are use of sex-linked crosses, or alternatively of light breeds in which the cockerels can be distinguished at about three weeks of age. Although this last method entails the expense of rearing a large number of redundant males to the age of three weeks, yet it is probably the most practicable method at the present stage, for the use of sex-linked crosses involves the maintenance of two separate flocks of pure-bred birds to be used for crossing purposes, and this necessarily entails the rearing of a fair number of pure-bred stock to provide material for the selection of breeding birds.

The choice of breeds, as outlined above, is largely influenced by the presence or absence of a market for meat, and will lie therefore in most cases with the light breeds. Apart from these considerations, it is important to remember that it is desirable to choose a breed which is already well represented in the country, so that there will be a sufficient number of strains to prevent the possibility of inbreeding, a danger in a country where it is of most vital importance to maintain the constitution of the stock. There is always a tendency to degeneration of progeny of imported stock, this being noticed particularly in size and weight and composition of the bone. In the opinion of the writer, however, these difficulties can in large measure be overcome by rigorous selection of breeding stock and careful feeding of suitable rations and mixtures containing the necessary mineral ingredients.

It is of great importance to adopt a definite policy and to continue with it, for the introduction of a large number of breeds and indiscriminate mixing leads eventually to the segregation of many bad types, and does not, as is sometimes

supposed, improve the constitution of the stock.

Problems of Housing.

As a rule, housing is not a difficult problem in this country, except in so far as it entails strict attention to cleanliness and protection from vermin of all sorts. A very important factor to bear in mind is that poultry always thrive best in small units, an economic unit being about 30 birds.

For this reason the Hosier system of portable housing units, each unit comprising about 20-30 birds, has much to recommend it, but it has also three grave disadvantages: —

(1) It is not suited for heavy breeds, as they do not get enough exercise, and tend to get too fat.

(2) It is absolutely essential to ensure that adequate provision is made for shading the units, as the birds will never thrive if exposed all day in the sun in one of these units without adequate protection.

(3) The grass on which the birds are folded should be short. Folding on tall herbage of the red-oat grass type leads to chills and scouring through the birds running about in the long grass when it is wet with dew or rain, and further they are liable to suffer from impaction of the crop through eating coarse and fibrous material.

Apart from these two latter pitfalls, and the fact that it is probably suited only to light breeds in this country, it combines all the advantages of keeping birds in small numbers, protection from vermin, since the unit is completely enclosed (house and run being made as one), and the provision of fresh unstained land for the flock.

If, however, the difficulties enumerated above cannot be overcome, or heavy breeds are kept, some form of permanent house and run must be used, but in this case it is most important to ensure that adequate provision is made for resting the runs, so that a grass cover can be maintained, the most obvious method being to divide the run into two so that it can be served by the one house. With regard to the house itself, this can be of very varied design, and many excellent types are to be seen in the country. A wire-netting floor (of small mesh, about 1 in.) is highly desirable, so that the droppings may fall through, either into a platform underneath, which can be moved and cleaned, or, if the house itself is movable, they may fall through to the ground and the whole house be put on a fresh site when the ground has become stained. Obviously houses of this type must be raised off the ground, and it is in fact always desirable that this should be done so as to provide a free circulation of air underneath. Birds should not be allowed to roost on the wire netting, but should always have perch space provided, for which it is better to use properly cut and planed timber than rough branches which are not so comfortable to the birds' feet. Nest-boxes should always be as dark as possible, so as to lessen the risk of birds eating the eggs, and if possible should have a front which can be shut down at night, and prevent birds roosting in them. Obviously the type of house mentioned above is most suited for small units, but where units of 100 birds or so have to be housed a more permanent type of building with wooden floor is required. There are diverse views with regard to the roofing of poultry houses, as to whether corrugated iron or grass should be used. While grass undoubtedly keeps the house cooler, yet it is absolutely essential that it should be removed completely and burnt periodi-

cally and the roof re-thatched so as to prevent vermin from being harboured in it. The same remark applies to the use of scratching sheds where the birds are provided with straw in which their corn is scattered. Unless these are thoroughly cleaned out and the straw burnt at frequent intervals, it is probably best to dispense with them altogether.

There is one fault closely connected with housing that is liable to occur, and that is the indiscriminate mixing of birds of different ages. This is in some cases due to the collapsing of partitions between runs, etc., which facilitates mixing, but also the fact that the harm done by such a practice is not always realized. Apart from the fact that the distribution of food is likely to be uneven, there is always a tendency when the older birds cease to lay and start to moult for younger stock to go into a neck-moult, which will either delay them from coming into lay or will put them off if they have already commenced. For this reason flocks should always be segregated as far as possible into: pullets not yet laying; pullets six months to one year; birds over one year; over one and a half to under two years; and birds two years and over. This will not usually involve any additional housing, but will yield much more satisfactory results. The fact that there is no definite hatching season in this country has probably been one of the chief factors contributing to this mixing of ages, for it entails a continuous supply of birds of all ages, and thus segregation becomes difficult, but provided the birds are divided into the categories described above results should be quite satisfactory.

Feeding.

The feeding of the birds will, to a large extent, depend on the foods that can be grown on the farm, and in most districts this provides a fairly extensive variety, but at all times it is necessary to supplement with certain purchased foods such as wheat offals, etc. As a general rule, maize bulks large in the ration fed to the birds, its chief recommendation being its cheapness. It is important to realize that many of the cases of digestive orders that occur (excessive scouring, liver troubles, etc.) are probably due in large measure to the use of maize in excessive quantities either in the mash or corn mixture. The relatively high price of chick wheat in relation to maize has deterred farmers from using it in sufficient quantities, with often very unsatisfactory results. It should be remembered that there are other foods in addition to maize and wheat, such as buckwheat, barley and sunflower, all of which can be used in a certain proportion in the corn ration, and which can be grown cheaply on the farm. It is unwise, however, to make any of these the basis of one's corn ration, which should always, as far as possible, be wheat, with these other grains in smaller quantities.

Finally, it is important to note that it is always preferable to feed good wheat in preference to droughted or pinched grain.

Examples of such rations are as follows:—

(1)
2 parts Wheat,
1 part Crushed Maize,
1 part Sunflower.

(2)
3 parts Wheat,
2 parts Crushed Maize,
1 part Buckwheat.

(3)
3 parts Wheat,
1 part Barley,
2 parts Crushed Maize,
1 part Sunflower,
1 part Buckwheat.

Maize should be fed kibbled, and sunflower slightly bruised so as to break the

outer husk. If one kind of grain is fed by itself, then wheat is the most suitable, the remainder being most suited to mixtures on the lines outlined above. A bird in full lay should receive 1½ oz. of grain per day, preferably in two feeds—early morning and evening.

There is a considerable divergence of opinion as to the desirability or otherwise of feeding dry mash as opposed to wet mash. In this connection it is important to remember that one of the chief advantages of dry mash feeding is economy of labour, an important consideration in Europe but relatively less so in this country. Unless carefully controlled, there is always the danger with the dry mash system that the birds will be eating an unbalanced ration, since they are able to pick the food over at will, so that its composition tends to alter and this may cause digestive disturbances. Further, since skim milk is frequently available in this country, which may be utilized for mixing with the mash, the case for wet mash feeding is further strengthened.

While the majority of the corn rations can usually be produced on the farm, yet it is essential to purchase certain feeding-stuffs for the mash portion. These are chiefly pollard, bran and meat meal. With reference to the latter, it is probable that this can be replaced at least partially by the use of vegetable protein, e.g. Soya beans, together with a mineral supplement. In this latter connection it is important to remember that nearly all the foods fed are themselves deficient in minerals, and it is therefore of great importance to add a complete mineral supplement to the ration. In this way growing birds will be enabled to form hard bone, the crooked breast-bones which are of fairly frequent occurrence being probably due to soft bone which has easily become bent will be eliminated; and further the minimum number of soft-shelled eggs will be laid. It is worth stating, however, in this latter connection that there are always a few birds in the flock which will lay soft-shelled eggs, however adequate the mineral supplement in their ration may be, this being due either to hereditary taint or some constitutional defect. Such birds should not, of course, be selected for breeding.

The chief minerals of importance and those most likely to be deficient are as follows: lime, phosphate, salt, iron (sometimes). These are most readily added in the ration in the form of ground limestone, steamed bone flour or meat and bone meal, salt finely ground, and iron oxide if necessary. The last is usually only required for young brooder and rearing chicks in cases where there is a lack of iron in the soil. Salt should always be finely ground, as it is toxic in large quantities, and should for this reason not be in a lumpy state when fed. The total mineral constituents should constitute about two per cent of the ration. If meat and bone meal is being fed, no steamed bone flour is necessary. The proportions of the minerals should be roughly as follows:—

Salt	½ per cent
Ground Limestone ...	1 per cent
Steamed Bone Flour	½ per cent

When iron oxide is being fed to young stock, only about ¼ per cent need be included.

A suitable laying mash where skim milk is available would be as follows:—

45	parts Pollard,
15	parts Bran,
30	parts Maize Meal,
5	parts Soya Bean (or other vegetable protein),
3	parts Meat and Bone Meal,
2	parts Minerals.
100	

Without Skim Milk.

45 parts Pollard,
13 parts Bran,
25 parts Maize Meal,
10 parts Soya Bean Meal,
5 parts Meat and Bone Meal,
2 parts Minerals.

100

The feeding of greenstuff of course is always highly desirable, and this should consist largely of kale, cabbages, etc. Poultry are as a rule not very fond of lucerne when fed long, owing to the large amount of stem present in relation to leaf. For this reason, if it is desired to feed lucerne, it is best to grind it up finely and incorporate it in the mash. The stemmy material is all reduced by the grinding, rendering it more palatable to the birds. In this manner it has a high feeding value, for it is rich in protein, and is of course largely used in Europe and America in the dried powdered form as Alfalfa meal, to replace some of the protein in the mash.

In addition to the provision of oyster shell for the birds, it is essential to provide some sharp grit in the mixture with it, if the soil does not already contain a sufficient quantity. It is essential that the grit should be sharp, as it is required to perform the grinding action in the gizzard which is necessary for efficient digestion. Often it is possible to find some rock or stone locally which, when broken up with a hammer, will serve the purpose.

The system of feeding outlined above is naturally somewhat expensive, but amply justified in pullets and second-year birds in full lay. Frequently, owing to lack of market, it is impossible to dispose of old birds when their period of maximum usefulness has passed, and yet they will probably continue to lay a few eggs, but not in sufficient quantity to justify elaborate or expensive feeding. Such birds are probably best ranched out in portable houses, risking vermin damage and allowing them free range. In this manner, together with a cheap corn ration consisting largely of maize, and possibly a little mash if the birds are in poor condition, although even this may be unnecessary, eggs will be obtained with the minimum expenditure, until such time as the birds cease to yield a return or preferably until a market can be found for them. It is extremely important to cut expenditure to the minimum on such stock, for the return will not be high, and output is not likely to affected appreciably by very cheap feeding, since quality of food has ceased to be the limiting factor in the birds' capacity to produce eggs. This feature again emphasizes the great importance of segregating birds into age groups.

Culling.

In every flock there are certain to be a percentage of birds which do not yield a sufficient return to justify the feeding, and these again might in some cases be treated in the manner suggested for old hens, if they cannot be disposed of in any other way. These birds are of two types, and are best discussed separately.

(1) *Wasters.*—These are birds which never put on flesh, but are always in a thin and unhealthy condition. They are chiefly found amongst the light breeds, where there has been a tendency to breed for egg production, sometimes at the expense of constitution. These birds are never likely to be of any use even to run with a "cull flock" and should be destroyed. They are always easy to detect by their poor condition and lack of comb and wattle development, or bad coloration of these organs.

(2) The other class consists of birds which are healthy in appearance, but either genetically or constitutionally are incapable of high egg production. These can only be culled out by frequent and careful handling of the flock. They usually tend to be loose-feathered birds, with a marked tendency in the case of the heavy breeds to lay on large quantities of yellow fat internally. The heads and combs are usually coarse and thick, and frequently the feathering in the heavy breeds is carried right forward over the head, the feathers being of a coarse and bristle-like nature. The distance between the pelvic bones is narrow and the points of the bones are large and feel definitely knobby as opposed to the finer points as found in a good layer. The region below the pelvic bones is usually lacking in capacity, with a tendency to a rather hard and tight skin. The scales on the legs, instead of being set on tightly, are frequently loose and of rather an open nature. A common feature of an unsatisfactory bird is the length of claw, but this criterion should not be applied in this country, where many of the soils are deficient in gritty material, with the result that the amount of wear and tear on the claws is necessarily very small.

For these reasons, great attention must be paid to the proper handling and culling of all laying stock, and, unless the birds are trap-nested, selection of breeding stock will depend on this handling also.

Selection and Handling of Breeding Stock.

If trap-nesting has been practised, the selection of breeding stock is rendered relatively simple, for the records of a large number of birds are then obtainable, and selection amongst the best of these is made on characters such as size, constitution, thriftiness, character of bone and breed points. As it is often difficult to trap-nest, owing to lack of suitable labour and facilities, in the majority of cases breeding stock must be selected by careful handling on the lines previously indicated. Where a flock has been culled regularly, this should prove a relatively simple matter, as the farmer will by then have acquired a sound knowledge of the technique of the handling of birds. If possible, no female stock should be used for breeding until they have reached the age of at least 12 months. By attention to this feature, the minimum number of weakly chicks will be obtained. In the case of the heavy breeds, 15 months is an ideal age for the selection of breeding stock. The male bird of a light breed can be used at an age of about 8 months, and in the case of a heavy breed 10 months, by which time he will have grown well. The use of birds at earlier ages than this definitely retards growth, and as it has been suggested may affect the constitution of the offspring. At the other end of the scale, it is very common to observe a decrease in the fertility of the eggs after the breeding stock have reached an age of about 2¼ years, depending on the breed. In most cases this is due to the male bird, and the number of females should then be reduced. Initially, in the case of a light breed, about 12 females should be allowed to one male bird, although 15 can be used, provided he is well grown and at an optimum age of about 1½ years. In the case of the heavy breeds the number of 10 females should not be exceeded.

It is frequently advisable also to select a small pen of 6 to 8 really first-class birds for purposes of cockerel breeding, and these are mated with an unrelated purchased male. In this manner a sufficient number of male birds are obtained for mating with the rest of the breeding

stock, without incurring the expense of the purchase of a large number of unrelated males. It is of great advantage to trap-nest such a pen, as any surplus cockerels can then be sold with a definite record behind them, which will naturally enable a higher price to be obtained. Such individually bred birds can be hatched out in the incubator in the normal way, by placing all the eggs from one of these six birds together in a small cage after about the eighteenth day, so that all the chicks from one hen can be toe-punched at birth or marked with a numbered ring affixed to the wing or leg before they have had the opportunity to get mixed with the rest of the hatch, with which they may be reared in the normal way.

In the ordinary breeding flock it is often desirable to run two male birds together with rather over double the number of females that would normally be allotted to a single male, as this usually leads to a higher fertility in the eggs. The chief objection to this system is that two male birds are often liable to fight together, but the risk of this is usually much lessened when the birds have been reared together, and when the breeding stock is allowed a fairly free range.

The feeding and management of breeding stock is substantially the same as that of the laying flock. A higher percentage (about 2 per cent more) protein should be included in the mash, and the birds should be allowed as much exercise as possible, not being confined in small runs or kept under the Hosier system. Absolutely free range, which is the ideal for breeding stock, is usually impracticable in this country on account of vermin. Where trap-nesting is practised, the eggs should, if possible, be graded, for it is frequently found that certain birds lay consistently small or misshaped eggs, unsuited for hatching purposes, and such stock should be discarded.

In the actual selection of the eggs themselves for hatching a good deal of care must be exercised. An egg weighing between 1¾ and 2 oz. is about the ideal size, and in addition care should be paid to such characters as shape, uniformity of shell, and cleanliness. The presence of an appreciable quantity of dirt closes the breathing pores. A slightly stained egg can, however, be cleaned with a dry or very slightly damp cloth.

All eggs to be used for hatching should be kept in a cool store with as uniform a temperature as possible, until it is desired to use them. They should be turned daily if possible during this storage period, and no egg more than ten days old should be used for hatching purposes. The practice of storing these eggs in bran or sawdust until required is not a very good one, and it is preferable to stand them on racks or other suitable container, so that air may circulate all round.

Methods of Hatching.

The majority of farmers in this country prefer to use incubators, but the broody hen has much to recommend it, and some of the larger poultry farmers in England are now returning to the use of these natural methods, believing that by so doing they retain the vigour and stamina of their stock. The great drawback in this country to the use of the hen is the problem of vermin, and unless the birds are clean this method should not be used. At least one farmer in this country has adopted the excellent practice of having the coops for sitting hens made out of sheet iron, so that they can be readily cleaned and freed from vermin. A series of these can be placed under a grass roof so as to prevent them from

getting too hot during the heat of the day. Where a large number of chicks are being hatched by this method it is desirable to tether each broody hen by one leg to its nest, and in this manner no confusion can arise when they are removed for feeding purposes. All sitting hens should be removed daily, and allowed access to corn and water, but laxative foods should not be fed, as this leads to fouling of the nest and eggs.

Towards the end of the incubating period it is desirable to damp the nest, for there is always a tendency for the eggs to become rather dry, and a certain loss through "dead in shell" will result. The advantages of the use of sitting hens may be summed up in a few words by saying that hatching by this method is simple when one is dependent on unskilled native labour, that the percentage hatch is usually greater than from an incubator, and that it is cheaper in first costs. The disadvantages are that many breeders who have only light breeds will have no sitting hens for the purpose, in which case it may mean keeping a certain number of birds of a breed such as the Light Sussex, which has proved to be unsatisfactory from the utility point of view in this country on account of the relatively small number and size of the eggs it lays. Alternatively, it may be possible to obtain a certain number of native hens, but these are often covered with vermin, and being small will not usually cover the full number of eggs, and, lastly, it is difficult to obtain the required number of broody hens at any given moment.

The majority of breeders will therefore use the incubator, but in this case frequent and strict European supervision is necessary, without which it will be almost impossible to obtain good hatches. In this country, it would appear that the hot water incubators are definitely preferable to the hot air types, chiefly on account of the smaller temperature variations in the former. The author has traced several causes of poor results from incubators in this country to failure to test the capsule before every hatch. This can always be done by immersion in hot water, making sure that it expands fully. Frequently, also, buildings in which the incubators are housed are at fault. Ideally an incubator should be housed in a cellar with a through draught created by windows placed high up on either side of the room. In this manner a fairly uniform temperature is maintained and good aeration secured. The floor of the room should be firm and level, so that the incubator does not rock about, subjecting it to vibration. While the practical difficulties usually preclude the construction of a cellar in this country, yet the principles embodied can be preserved by constructing a thick-walled mud and wattle hut, roofed with corrugated iron, the whole roof being then covered thickly with a layer of grass, maize trash, etc., to ensure a uniform temperature. Ventilation should be provided in the manner described above. Preferably the hut should be situated where there is shade overhead. The incubator itself should be run empty for several days before it is used, to ensure uniformity of temperature before the eggs are introduced. The practice of marking each egg with a nought on one side and a cross on the other is always advisable, in spite of some opinion that this is not necessary, for only in this manner can complete turning be ensured, which is essential for successful results. The shallow troughs provided for water in the incubator should be kept filled, always filling with warm water, which will give off vapour immediately and maintain the necessary humidity in

the atmosphere. The floor of the incubator house should be covered with sand, which can also be kept damp. The most successful results seem to have been obtained by running at a temperature of slightly over the accepted figure of 103° F., up to 104° F. having yielded very good results. Great attention must be paid to the turning of the eggs, and they should be turned completely twice daily. Great care must also be exercised in the handling of the eggs, as the presence of one defective egg in the incubator can cause the liberation of gases which will prove toxic to the developing embryos.

The incubator should not be opened again after the 18th-19th day, depending on the temperature at which it has been running, but the thermometer must be examined very frequently after this, as heat develops rapidly as the young chicks respire actively in their shells. After hatching, no chicks should be removed from the brooder till thoroughly dry, but should be allowed to stay in the special compartment for this purpose. The latest hatched chickens may be left in the incubator after the others have been removed, and introduced into the brooder at night. For the first day the chicks require no food, but water and fine grit and shell should be provided. The practice of feeding hard-boiled egg is unnecessary, as the chick has considerable reserves of food in its body, which it requires to digest before it is induced to eat other foods. On the second day after removal from the brooder a mash can be commenced. A specimen is appended below. Skim milk should be fed separately to very young chickens, although if desired a very small quantity can be used to make the mash into a very stiff paste, which should be crumbly in texture. Where skim milk is not available, a proportionately higher amount of protein will be required, and the inclusion of 1 per cent of cattle cod-liver oil is extremely desirable. Great care must, however, be taken in mixing this in with a mash, since it is important to incorporate it uniformly so that no excess will be present.

	Percentage Figures.		
	Brooder.	Grower.	Fattenings.
Pollards	50	45	30
Bran	20	28	14
Maize Meal ...	23	20	50
Meat and Bone Meal	5	5	4
Minerals ...	2	2	2
	100	100	100

Skim milk *ad lib.* to brooders and fattening birds; to others more limited quantities.

(*Note.*—A brooder is a bird up to 8 weeks, and a grower any bird over this age up to time of laying.)

The ration inserted for fattening birds is a suitable ration for surplus cockerels which it may be desired to rear for table purposes. Chopped greenstuff in the form of cabbage or kale leaves or very finely chopped lucerne can be usefully incorporated in the mash, but on account of its rather fibrous nature, it is best not to use lucerne until the birds are eight weeks old. The small runs provided for the brooder chicks should be moved constantly and should always be kept on short grass; any long grass will inevitably lead to chills and other troubles. Again one must emphasize the importance of segregation of age classes in rearing as well as in adult stock. The rather common practice of mixing rearing chickens of all ages is probably quite a possible cause for the appearance of a high percentage of "runts". All unwanted male birds should be selected as soon as possible, and fed on the cheaper ration outlined for fattening birds above. Where

prices are low or demand poor for such birds this ration can safely be commenced at a relatively early age, so that costs may be brought as low as possible, and, if necessary, a portion of the mineral ration can be omitted. For young chickens the iron oxide is a most essential constituent of this ration, and should not be omitted. It is important to remember that iron is a very essential constituent of the blood, and lack of it may produce a fair proportion of wasters in the young stock.

A corn ration should be given to the rearing stock at the age of about four months, depending on the breed. If maize is used as one of the ingredients it should be kibbled small. Owing to the rapid rate at which stock grow and mature in this country, many farmers wish to retard their birds from coming into lay, in order that they may be given a good chance to grow out. The only way in which this can safely be done is to move them to fresh sites constantly, but any system such as reducing protein in the ration is to be deprecated in the case of a growing bird. Provided the birds have been well fed, there should be little danger in too early laying, and resort to drastic methods to delay this should not be adopted.

Conclusion.

In this brief article an attempt has been made to show that, provided management is conducted on sound lines, there is a considerable future for poultry as a side-line to mixed farming activities in Kenya. It would appear likely that, with the present increasing production, the possibilities of export will again come to the forefront, and it will then perhaps be necessary for producers to accept a somewhat lower price than prevails at present, which will only be possible if continued progress is made on the lines of good management.

Virus Diseases of East African Plants

IV.—A Survey of the Viruses Attacking the Gramineae

By H. H. STOREY, M.A., *Ph.D., East African Agricultural Research Station, Amani, Tanganyika Territory.*

The grasses, or *Gramineae,* are a family of great economic importance; they are of especial interest from our present point of view because of the diversity of virus diseases to which they are known to be subject. Including as it does such valuable tropical crop plants as sugar cane, maize and sorghum, the family has received particular attention from plant pathologists. Probably few diseases have been studied by more investigators than mosaic of sugar cane. The considerable number however of the viruses now known to attack these plants may well be due to recognition, as a consequence of this extensive study, rather than to any exceptional susceptibility of the group.

The multiplicity of viruses recognized as causing diseases of *Gramineae* makes our problem one of considerable complexity. The complexity is increased by the fact that, whereas some viruses have a wide host-range, others exist as strains specialized to particular species of plants. In the present article I shall survey briefly the several viruses known to attack *Gramineae* in East Africa, leaving to later articles the detailed accounts of certain of them. Extensive as is the list that follows, it is probably not exhaustive; while several diseases of great economic importance, known in countries outside East Africa, have been omitted.

The difficulties involved in the differentiation of viruses, to which reference was made in the first of this series of articles, are here acute. The modern tendency is to discredit symptoms as a reliable differential character; and, as we shall see, this attitude is justified by some of the evidence that we shall proceed to consider. But obviously we cannot discard the use of symptoms, for it is by them alone that we are made aware of the presence of a virus. And symptoms, used with due caution and as far as possible in conjunction with other differential characters, such as the mode of transmission, need not be unreliable. On this basis the following attempt to classify the viruses that are known to attack East African *Gramineae* has been made.

I.—The Common Sugar Cane Mosaic Group.

A description of mosaic disease, as it occurs in sugar cane in Uganda, has recently been given by Hansford in this Journal (Hansford, 1935). While repeating his account as little as possible, we may note that the virus produces a mottling upon the leaves of sugar cane, consisting of areas, generally more or less elongated along the leaf-blade, of dark green, pale green or yellow tissue (Fig. 1). The markings are most clearly seen on young, recently unfolded leaves. In some varieties the mosaic markings disappear entirely as the leaf ages; but on the other hand various other markings may appear on older leaves, that might be confused with the symptoms of mosaic. A diagnosis of this disease should always be based on an examination of the youngest leaves.

In a single variety of sugar cane the mosaic pattern is generally uniform; but there may be large differences in the character of the pattern produced in different varieties. This fact might lead to the suspicion that several virus strains

are involved. But, for the most part, there is good evidence that these varying patterns are but different manifestations of infection by a single virus. There is also evidence that this virus may be transferred, without change, to maize (Fig. 2), certain varieties of sorghum and many wild grasses. It is generally agreed that this virus originated in the East, and has thence been distributed in sugar cane cuttings to most sugar-growing countries; it is therefore not unexpected that we should find in all these countries a single virus of uniform behaviour.

There is however evidence that strains of the mosaic virus, differing from the common one considered above, may occur. Several such strains, differentiated by the symptoms produced in selected varieties of cane, have been recognized in Louisiana (Summers, 1934). Cane varieties found to be immune in most countries, have been reported as affected in Georgia (Yoder, 1926). Finally in the Transvaal, I found a virus, attacking maize and sorghum freely, that was entirely non-virulent to sugar cane (Storey, 1929).

FIG. 1 FIG. 2 FIG. 3

FIG. 1—MOSAIC DISEASE IN SUGAR CANE.—A common type of mosaic pattern in a thick tropical cane variety.

FIG. 2—MOSAIC DISEASE IN MAIZE.—The leaf is of a paler green than normal, with occasional stripes of darker tissue. A similar pattern is shown by some varieties of sugar cane.

FIG. 3—"AGAUL" MOSAIC DISEASE.—A young leaf of the cane variety, Agaul, showing the characteristic mosaic-like pattern.

All these strains of the virus, so far as is known, are transmitted by *Aphis maidis*. They are also transmissible, with some difficulty, by needle inoculation.

II.—"AGAUL" MOSAIC.

A sugar cane variety, Agaul, imported to Natal from India many years ago,

is now found, both in South and East Africa (whither it was imported from Natal), entirely affected with a mosaic disease. The pattern shown by the young leaves (Fig. 3), is quite typical of the mild symptoms of the common mosaic disease. Many attempts made at Amani to transfer the virus, by needle inoculation and by means of *Aphis maidis*, have all failed. Nor is there any evidence that natural spread to other varieties has occurred in the field. For these reasons I tentatively separate this virus from the common mosaic group.

III.—The Streak Group.

The symptoms of streak disease consist of narrow yellow or nearly white stripes of varying length following the parallel veins of the leaf. In sugar cane this effect is marked (Fig. 4), and serves readily to distinguish this disease from mosaic. The same general pattern is shown by maize (Fig. 5), and other host plants, but the width of the stripes may vary and adjacent stripes may fuse.

Streak disease occurs in sugar cane, maize and a large number of wild grasses. The evidence shows however that each host, or perhaps group of hosts, has a strain of the virus specialized to it. This, at least, has been definitely demonstrated for sugar cane and maize (Storey and McClean, 1930). The virus that produces the severest symptoms in maize (Fig. 5), is incapable of attacking sugar cane; on the other hand, the sugar cane strain produces only a mild form of the disease in maize (Fig. 6). Recently another strain, apparently also specialized to maize, has been recognized (A. P. D. McClean, *in lit.*).

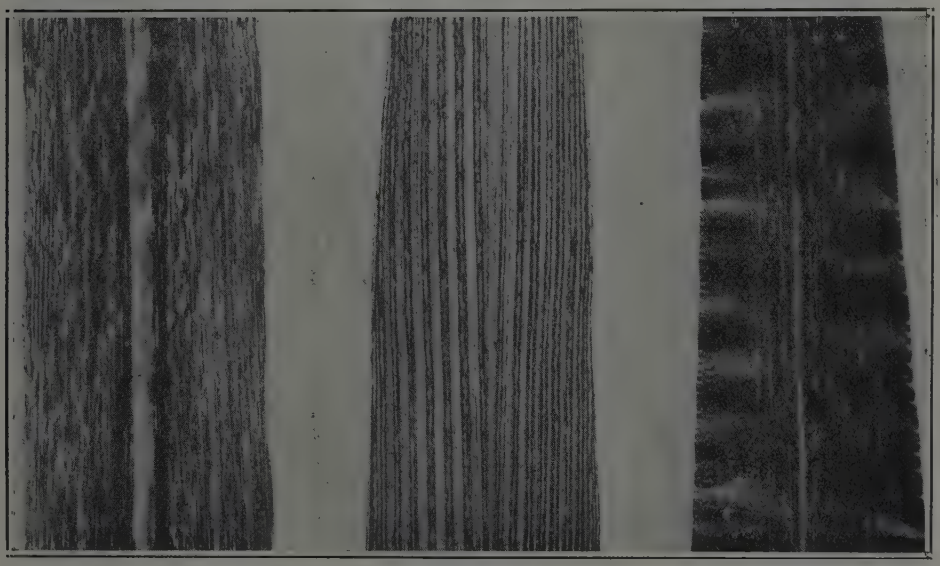


Fig. 4 Fig. 5 Fig. 6

Fig. 4—Streak Disease in Sugar Cane.—A leaf of the variety Uba.

Fig. 5—Streak Disease in Maize.—The typical severe form of the disease.

Fig. 6—The Effect of the Cane Streak Virus on Maize.—Leaf of a maize plant infected by transfer of the streak virus from Uba cane.

The above virus strains are all transmitted naturally by species of the leafhopper, *Cicadulina*. They cannot be transferred by needle inoculation.

IV.—"R.P.8" Streak.

A number of years ago streak disease of sugar was reported in Mauritius (Shepherd, 1929). It occurred only in one variety, R.P.8, and spread to other plants of this variety but to no other variety. A diseased plant of R.P.8, imported into East Africa, was recently intercepted in quarantine, and this plant has provided me with material for study.

The symptoms in R.P.8 are perfectly typical of streak disease. Repeated attempts to transmit the virus to maize and to healthy R.P.8 and other cane varieties, by means of *Cicadulina* spp. and *Peregrinus maidis* (*see* No. V), have all failed. We may suspect here, as with No. II, that the virus concerned is distinct from the common one that it so closely resembles in its symptoms.

V.—Stripe Disease.

A disease of maize, hitherto recognized in Africa only in the Amani district, resembles streak in its symptoms so closely as often to be indistinguishable from it. These symptoms are yellow stripes along the veins, tending however to be longer without a break than those of streak, sometimes rather wide and separated by considerable areas of green tissue (Fig. 7), sometimes narrow but so

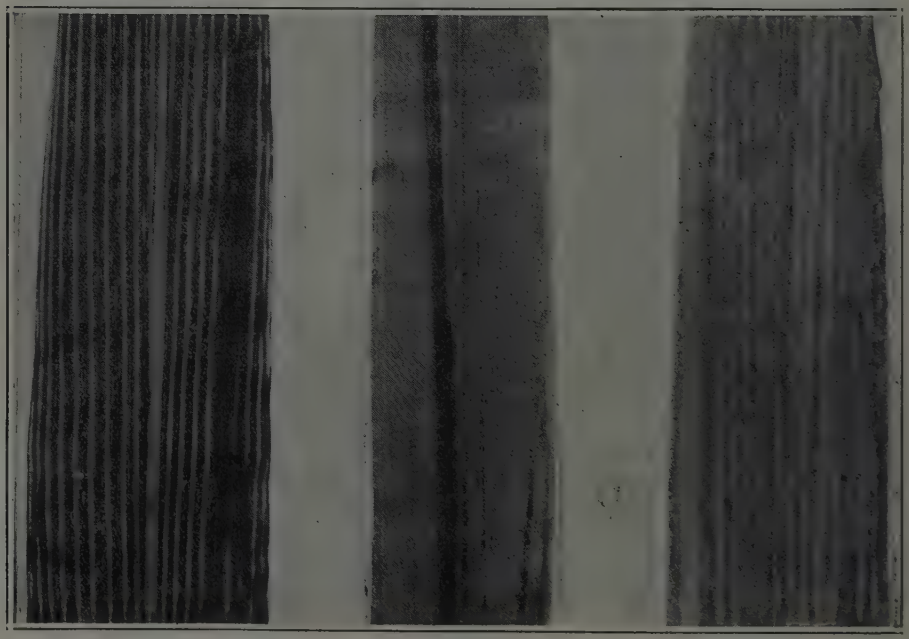


Fig. 7 Fig. 8 Fig. 9

Fig. 7—Stripe Disease in Maize.—One type, with the yellow stripes separated by wide areas of green tissue.

Fig. 8—Stripe Disease of Maize.—A second type, where the yellow stripes are so crowded as to fuse together to form a solid yellow area.

Fig. 9—A New Mosaic-like Disease of Maize.—Young leaf showing the characteristic mottling.

closely crowded that large areas of the leaf become nearly entirely yellow (Fig. 8).

The differential character of this virus is that it is transmitted by a leafhopper, *Peregrinus maidis*, and not by the species of *Cicadulina* that transmit the streak virus.

This virus is perhaps identical with one recorded in Hawaii (Kunkel, 1927), Cuba (Stahl, 1927) and Trinidad (Briton-Jones, 1933), as transmitted by *Peregrinus maidis*. It is also reported by Shepherd (1929) to occur in Mauritius. This author suggests that "R.P.8" streak may be due to the stripe virus: but, as noticed above, I have obtained no evidence to support this suspicion.

The stripe virus is not known to be transferable, in East Africa, to any species of plant other than maize.

VI—A New Mosaic-like Disease of Maize.

The symptoms, illustrated in Fig. 9, have been produced in the greenhouse in maize seedlings exposed to the feeding of certain leafhoppers of the species *Cicadulina*, collected on maize near Amani. The diffuse blotching effect is readily seen in a newly unfolded leaf of a plant recently infected. As the leaf ages, however, all markings disappear, and in its later growth an affected plant may show no markings even on its youngest leaves. Owing to the transitory nature of the symptoms, the disease has not been certainly diagnosed as yet in maize plants in the field.

Although investigations of this disease are still in an early stage, they have advanced far enough to show that it is due to a virus transmitted by the same species of *Cicadulina* as transmit the streak virus. In view of this finding the suspicion arises that this may be an unusual strain of the streak virus. But the general character of the symptoms of the two diseases is so different (compare Figs. 5 and 9) that this appears to be unlikely, nor have experiments on other lines suggested any relation between the two.

The diseases considered under the preceding headings all exert a more or less serious effect in reducing the yield of plants that they affect. This new disease however appears to have little influence on the growth of an affected plant.

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The Weather of 1935

A preliminary examination of the results from Second Order Stations gives the following information in regard to the first half of the year. The second half of the year will be dealt with in the next issue.

Rainfall.—The following table shows how the rainfall varied from the normal in the various parts of the territory:—

Stations	Departure from Average	Maximum Falls: In 24 hours		Maximum Falls: In a Month	
	Ins.	*Ins.*	*Day*	*Ins.*	*Month*
Marsabit ..	+7·58	3·32	30th April	12·61	April
Kitale	+4·73	1·61	24th May	12·33	May
Eldoret ..	+8·07	1·64	7th April	11·06	May
Kisumu ..	+6·37	2·03	19th May	9·30	April
Nakuru ..	—3·59	1·30	12th May	5·24	May
Nairobi ..	—4·90	2·06	11th May	6·58	Feb.
Limuru ..	—7·22	1·52	12th May	10·57	May
Kiambu (Kasarini) ..	+3·16	1·81	21st Feb.	7·70	Feb.
Mombasa ..	+2·00	4·26	25th May	15·26	May
Gulu	+3·73	2·58	28th June	10·14	May
Lira	+2·28	2·03	30th April	10·04	June
Butiaba ..	—0·78	1·61	28th May	6·46	May
Soroti	+7·18	2·66	9th May	13·38	May
Mbale	+0·32	1·93	13th April	9·26	May
Fort Portal ..	+7·38	3·40	4th Feb.	6·82	June
Mubende ..	+1·41	3·27	8th June	5·77	April
Kampala ..	+2·71	2·04	9th June	8·15	May
Jinja	+2·11	1·83	24th Feb.	7·28	April
Tororo	+4·56	2·67	9th May	11·88	April
Mbarara ..	—2·95	1·15	9th April	4·38	Feb.
Kabale ..	+6·72	2·02	11th June	6·22	May
Mwanza ..	—1·76	1·72	9th April	7·73	April
Moshi	+2·99	3·80	12th April	9·80	May
Kigoma ..	+8·95	3·90	28th Feb.	9·76	March
Kondoa Irangi	+0·06	3·43	20th Feb.	9·56	Feb.
Tabora ..	—1·71	1·48	9th April	5·28	Feb.
Dodoma ..	—7·39	3·09	28th Jan.	5·24	Feb.
Dar es Salaam	+2·76	2·49	14th May	17·53	May
Iringa	+2·76	2·19	28th Jan.	9·30	Feb.
Mbeya ..	+1·37	1·67	28th Feb.	9·69	Feb.
Lindi	+0·78	2·02	26th Feb.	8·46	Feb.
Zanzibar ..	+7·84	4·26	3rd May	17·07	May

It will be noted that rainfall was generally in excess of normal in Uganda, and also in Kenya with the exception of the area between Nakuru and Nairobi. Kiambu (Kasarini) however, was 3 inches in excess of normal. Central Tanganyika was below normal, but other parts were above. Zanzibar was well in excess.

The greatest falls in one day were 6.10 inches on 7th May at Moyale in Kenya, 3.40 inches on 4th February at Fort Portal in Uganda, 3.90 inches on 20th February at Kigoma in Tanganyika, and 4.26 inches on 3rd May in Zanzibar.

Temperature.—The temperature during the period under review was generally about normal. The warmest areas, allowing for altitude, were the north of Uganda and Central Tanganyika. The highest and lowest temperatures were:

KENYA—
Max. 96°F. on 1st and 2nd February in Lambwe Valley (Kisii).
Min. 39°F. on 25th January at Eldoret.

UGANDA—
Max. 98°F. in January and February at Soroti.
Min. 43°F. on 30th May at Kabale.

TANGANYIKA—
Max. 98·4°F. on 20th January at Moshi.
Min. 40°F. on 16th June at Mbeya.

ZANZIBAR—
Max. 96°F. on 22nd February.
Min. 70°F. on 4th May.

Pressure.—There is little variation in pressure over East Africa and a slight pressure gradient from north to south persisted throughout, with a region of comparatively low pressure over the Lake area.

Weather.—An outstanding feature in Kenya was the heavy rain in February in the Nairobi area, which made up in some measure for the rather poor rains later. This appears to have been due to opposing upper winds causing unstable conditions favourable to strong convection.

February was also wetter than usual in parts of Uganda and in Tanganyika. May was the wettest for some years in Tanganyika.

(*Continued on page* 339)

A Short Review of the Sisal Markets for the Year 1935

By A. WIGGLESWORTH.

The year 1935 is notable as the turning point in four years of unprofitable prices. The rise has been greater than was anticipated even by the greatest optimists. Many factors have contributed to the change. Firstly, little planting beyond renewal has been done in any sisal-producing country since the price fell so low. Secondly, the careful grading and regular deliveries of African sisal have led to an increase in its consumption for ordinary purposes. Thirdly, research work is leading to its introduction to entirely new uses, one instance of which is the adoption of tow as an upholstering material for mattresses, this having diverted a large part of the tow production. Fourthly, vast improvements in spinning machinery now enable spinners to secure a finer yarn of higher value. Fifthly, last year's grain crop in the United States and Canada exceeded expectation, absorbing heavy stocks of twine which had been accumulating during the previous two seasons, which produced notably poor grain crops.

As sisal takes anything from three to five years to produce after planting, and manila about one-and-a-half to two years, a change in the market situation is liable to last longer than in the case of annual crops.

The year 1935 opened with No. 1 African sisal at £15, and at the date of writing the price is £27 per ton. Mexican sisal opened in January at 3 cents per lb. (U.S.A. cents) and ended to date at 6⅛ cents per lb. Java sisal opened at Fls. 12¼, and is now Fls. 20. All three markets kept remarkably steady for four months, but towards the end of May a rise set in. Large sales of Mexican sisal early in June, representing 50,000 tons, cleared the decks of accumulation, and threw the demand on to the producer, thus bringing about a steady rise in price. In September, a sharp rise in African took place, from £19 to £26 per ton, coinciding in a corresponding increase in the price of Mexican. Notwithstanding the resistance of manufacturers to so substantial an advance, prices went still higher, and, probably as a result of the Italo-Abyssinia war depriving the world of supplies of Italian hemp, a further advance subsequently took place, resulting in the sale of bulk supplies for about six months ahead.

It is generally believed that America has still to make large purchases for the next harvest. Meanwhile, Europe continues to absorb the greater part of the production of African sisal.

In conclusion, undoubtedly the improvement in plant and creditable care and attention to brushing, grading and colour, may be responsible for the popularity of the fibre and help to secure the better price now obtainable.

(*Continued from page* 338)

The Weather of 1935

While the rains of April and May are brought by the south-east monsoon, this wind current is controlled over East Africa by cyclonic disturbances moving up from South Africa to Madagascar. The movements of these disturbances explains in a large measure the vagaries of these rains and long period forecasts will have to take into account not only the probable strength of the monsoon current but the activity of these comparatively short-lived disturbances.

Elephant Grass (*Pennisetum purpureum*) as a Cattle Fodder in Kenya

By COLIN MAHER, *M.A., Dip. Agric. (Cantab.), A.I.C.T.A., Agricultural Officer, Kenya Colony.*

"Elephant Grass" or "Napier's Fodder" is a tall, densely tufted, perennial grass which grows from 6 ft. to 20 ft. high, according to the altitude or the climate in which it is grown. The stems are about ¾ in. thick and the leaf blades, which are often slightly hairy, are 1 ft. to 3 ft. long and 1 in. wide. The midrib is stout. The grass is indigenous to Uganda, Kenya Colony and Tanganyika Territory and makes its maximum growth when growing at the sides of watercourses, where moisture is readily available; it will not, however, tolerate ill-drained conditions and stagnant water.

It has been grown in Kenya at altitudes of 7,000 ft. and over, but is more at home at altitudes of 6,000 ft. and lower, especially where there is a rainfall of 40 in. or more. Although it loves a high rainfall, this grass shows considerable powers of drought resistance in drier areas or in the dry season. When the rains are heavy and the atmospheric humidity is high the grass shows spots of white mycelial growth due to *Beniowskia sphaeroidea* (K. & Cke). This fungus does not appear to do any serious damage, however, and rapidly disappears in the dry weather.

PROPAGATION.

The grass rarely, if ever, flowers under Kenya conditions—at any rate under the conditions operative in the European farming areas—and is propagated by means of rooted tillers (or "suckers") or by portions of the stems.

The land should be well prepared and, if perhaps one cleaning is given after planting, the elephant grass should be able to hold its own against the competition of weeds or other grasses, if sufficient moisture is present in the soil after planting to enable the roots to start growth. The setts should be planted 2 ft. apart in rows 3 ft. apart. If "joints" are used, only the mature and woody portions of the stem should be taken—the leaves having been stripped off—since the younger, sappier, portions will wilt and die without taking root. There should be at least two nodes or joints to each sett and the lower of the two nodes should be buried by the soil, since from this node the adventitious roots will emerge while the leaf shoot will appear from the upper node or nodes. It is desirable to plant the portions of the stem at an angle of 45 degrees and the soil should be well firmed round the sett in order to bring the moisture of the soil into close contact with it.

THE UTILIZATION OF ELEPHANT GRASS.

In most districts of Kenya it is advantageous to cut elephant grass every three months. The following figures are from a report of an experiment carried out with elephant grass at the Imperial College of Tropical Agriculture in Trinidad in 1932:—

Series A.—Cut every 4 weeks.
Series B.—Cut every 8 weeks.
Series C.—Cut every 12 weeks.

The total yields over an eleven-month period were as follows:—

	Green Fodder		Dry Matter	
	Yield in tons per acre	Percentage of Series C	Yield in tons per acre	Percentage of Series C
Series A	24·1	56·5	3·39	39·2
Series B	37·7	83·7	5·68	65·4
Series C	42·7	100·0	8·70	100·0

"In nutritive value, the average grade of green fodder from the experimental area is roughly equivalent to medium quality meadow hay ready for harvest. The elephant grass is rather lower than the hay in crude protein. When compared with pasturage in England on a monthly cropping rotation, even the least mature cuts of elephant grass from Series A gave a very low protein percentage. Analysis of very young shoots of elephant grass showed that, in protein percentage, they resemble similar pasture cuts in England. The more rapid growth in the tropical fodder appears to produce a much quicker drop in the protein percentage, so as to make it impossible to obtain, from elephant grass grown on a field scale, a fodder with a close nutritive ratio.

	Protein Percentage		Total Yield of Protein	
	In dry matter	Expressed as a percentage of Series A	Tons per acre	Expressed as a percentage of Series A
Series A	9·85	100	0·34	100·0
Series B	7·43	82	0·42	123·5
Series C	6·09	62	0·52	153·0

Therefore, Series C gives much the highest yield of protein per acre: the produce from this series is considerably lower in protein percentage than that from A or B but the greater bulk of green fodder and of dry matter from the longer cutting rotation adopted more than compensates for this."

Dairy farmers in districts where there is a dry season lasting from December to March should take the last cut, before the onset of the dry season, in September or October. A cut can then be taken in January or February when the green fodder will be of great value owing to other green foods being scarce.

During the wet weather there will be little or no need for green fodder additional to the pasture grazing and the elephant grass can be turned into silage, used for mulching, or used in the manufacture of compost.

The crop may be cut for silage at the same stage as for green fodder, that is at about 4 ft. high when three months old. The stalks should be cut into lengths about 6 in. long and filled straight into the silo or silage pit. It does not give quite such a palatable silage as maize and an improvement would be to mix ⅓ or ¼ its weight of cow-pea fodder when making the silage. The grass should be well trampled into the pit, especially round the edges, and not more than 3 ft. or 4 ft. in height should be added each day or the resulting silage will be very sour.

A maintenance ration of elephant grass is said to be 80 to 85 lb. a day. Experiments in Trinidad in 1931 gave the following results for elephant grass:

I. Analysis

Elephant Grass—	
Moisture	83·23
Crude Protein	1·27
Ether Extract	0·28
Crude Fibre	4·92
Nitrogen-free Extract	7·83
Ash	2·38

II. Digestibility

Elephant Grass—	
Moisture	59
Crude Protein	64
Ether Extract	45
Crude Fibre	62
Nitrogen-free Extract	61
Ash	43

III. Nutritive Value (100 lb. Samples)

Elephant Grass—Total Dry Matter	16·68
Digestible Nutriments in lb—	
Crude Protein	0·8
Ether Extract	0·13
Crude Fibre	3·05
Nitrogen-free Extract ..	4·8
Starch Equivalent	7·15

Nutritive Ratio 1:10

IV. Average Daily Consumption of Nutriments

	Green Fodder	Dry Matter	Digestible Protein	Starch Equivalent
Elephant Grass—				
(*a*) Actual amounts in lb.	114	19	0·9	8·2
(*b*) Calculated amounts for maintenance in lb. ..	80	14	0·6	5·8

An increasing number of farmers grow elephant grass as a reserve feed for their working oxen in the dry season. In this instance the cattle are usually turned loose and grazed on the grass. This method is not so economical of the grass and does not permit of the greatest yield of fodder being obtained, as the stools of the grass are not given the necessary resting periods. Where it is desired to make as much manure or compost as possible, the grass may well be fed in racks placed in small *bomas*; the grazing method is, of course, more economical of labour.

In order to avoid danger of the cattle becoming "blown", care should be taken that they are not given more than a short time during which they are permitted to graze on the elephant grass; it is particularly necessary to take this precaution if the cattle have only been accustomed to poor grazing and are in bad condition. When the cattle are used to grazing on this grass there seems to be little or no danger, and they will soon show the benefit derived from this fodder in their sleek condition, even when working, and their shiny coats. Elephant grass is equally appreciated by young stock and by horses.

Elephant Grass as a Soil Improver.

Land which is under elephant grass for several years increases considerably in fertility. This grass comes in naturally on land which has been devoted to fallow for three years in Uganda; and experiments have been started at the Bukalasa Plantation of the Uganda Department of Agriculture which are intended to show whether the native rotation of six years fallow can be reduced to three years by means of planting elephant grass immediately a field is taken out of crops.

The improvement of the soil under elephant grass is partly owing to the increase in humus content due to the fallen trash and partly, it may be presumed, to the prevention of wash and the protection of the soil from the tropical sun.

In some districts some difficulty may be experienced in ploughing under the old stools of elephant grass, unless a very heavy plough is available. The vigour of the grass may be reduced, however, and ploughing facilitated either by taking several cuttings in rapid succession or, more economically, by grazing the grass very hard. It may be feasible, for instance, to make night *bomas* on portions of the field and to plough the land which has been grazed over when the *bomas* have been moved on to a fresh spot.

High Nutritive Value of Sesame Seeds*

Sesame seeds are an important article of food in Asia, Africa and the Near East, having been used for centuries either as a staple, or for ceremonial purposes. Travellers in North China are familiar with the small rich flat cakes, thickly coated with sesame seeds and tasting somewhat like Scotch shortbread, and one of our imported delicacies is the *halva* of Southern European countries, combining sesame with honey.

Until recently, one of the chief merits of sesame seeds—the fact that they are extremely rich in calcium—had escaped the attention of nutritionists. Three types of whole sesame seeds (*Sesamum orientale*) analysed last year by the Department, from seeds grown in Arizona, averaged about 1 per cent of calcium. These findings confirmed those in published reports from other parts of the world in showing sesame seeds to be far richer than any of our common plant foods in this important element. They are rich, too, in protein of good quality, in fat, and in phosphorus. The seeds have a very agreeable taste, especially after roasting, and, like nuts, they can be used in many ways in the diet. In view of these facts sesame seeds appear to have excellent possibilities as food, especially in diets than need to supply an abundance of calcium.

The calcium content of the whole seed is very much higher than that of the decorticated seed, since much of the calcium lies in the seed coat. The creamy white seed that is used to some extent by the bakers in this country is the decorticated seed imported in this form from China.

According to data compiled from various sources the percentage composition of the whole seeds is about as follows: Water, 5.8; protein (N. x 5.3), 19.3; fat as ether extract, 51.1; total ash, 5.7; crude fibre, 3.2; and carbohydrate by difference, including fibre, 18.1. The calcium and phosphorus content of the seeds is about 1 and 0.7 per cent respectively, expressed as the element in percentage of air-dry substance. No satisfactory data on iron content are available. The decorticated sesame seed contains only about 3 per cent total ash, 0.08 per cent calcium, and 0.68 per cent phosphorus, judging by a single imported sample analysed last year by the Bureau of Chemistry and Soils.

The nutrition laboratory of the Bureau of Home Economics has shown that the whole brown sesame seed fed to rats as a supplement to a low calcium diet was effective in promoting growth and bone development. Decorticated seed used as a supplement gave poor growth, little better than that of the negative controls that received no calcium supplement.

Sesame-seed recipes developed in the Bureau of Home Economics include muffins, cookies, and a brittle similar to peanut brittle, as well as directions for roasting and salting the whole seeds. Many other uses are possible, in breads and cakes, or even in soups.

In Palestine sesame seeds are pressed to produce a light edible oil. The residue is used for mixing with flour and sugar to make *khalawe*, a hard white jam, eaten with bread by the Arab population. This is a very important article of native diet, and is made in large quantities. Factories producing *khalawe* abound in Palestine.

V.L.

* Extracted from *U.S. Yearbook of Agriculture*, 1934, pp. 316-17.

Agricultural News

Iringa District, in the Southern Highlands of Tanganyika Territory, held its first Agricultural Show from the 10th to 12th of October. The show was educational rather than competitive, although a few awards were made for various classes of farm produce, which included cereals, tobacco, and pork products. There were some fine exhibits of budded fruit trees and general nursery stock. Tea and tobacco, as the most important European products of the district, were of course much in evidence. Other outstanding exhibits were the products of the new Mtitu bacon factory, and also jams and preserves.

Government departments were represented by the Agricultural and Veterinary Departments. The exhibit of the former was devoted mainly to demonstration of anti-soil-erosion methods by means of clay models; and also of composting by a modification of the Indore method. This was supported by tobacco, cereals, and the general crops under trial at the Iheme Agricultural Station. The Veterinary Department staged practical demonstrations daily in the preparation for shade drying of hides and skins. Specimens of leather manufactured from shade-dried skins were contrasted with others. Suitable grasses for permanent pastures and anti-erosion measures were on view. There were also interesting exhibits of clarified butter and locally grown pig-feeds. Horses were a feature of the show and the races on the closing day attracted much attention.

Both from a financial and educational point of view the show was a great success. It is now intended that it will be an annual event, and an agricultural society is being formed for this purpose.

BEESWAX: IMPERIAL PREFERENCE.

It is notified for information that as from the 28th of August, 1935, the British Preferential Tariff on Beeswax imported into the United Kingdom has been extended to the non-self-governing Colonies, Protectorates and Mandated Territories.

The British preferential rate is 1d. per lb., the general rate being 4d. per lb.

(*Continued from page* 277)

Report on Grassland Improvement, etc.

The results are as follows (Table 2):—

TABLE 2

DRY MATTER BASIS

GRASSES	Crude protein	Total ash	Silica-free ash
Pennisetum clandestinum	10·3	9·7	6·2
Cenchrus ciliaris ..	12·5	13·1	10·6
Panicum coloratum ..	11·8	10·7	8·0
Amphilophis pertusa ..	9·1	13·4	4·3
Paspalum dilatatum .. (Leaf only)	13·0	11·5	5·7
Chloris gayana.. ..	7·9	10·7	5·6

It has not yet been possible for this Department to provide facilities for chemical work in connection with grassland investigation, and it is indebted to Professor R. G. Linton, of the Royal Veterinary College, Edinburgh, for kind assistance in providing both sets of results given above.

Reviews

BIOLOGICAL PROCESSES IN TROPICAL SOILS, WITH SPECIAL REFERENCE TO MALAYSIA, *by* A. S. Corbet. Heffer; 7s. 6d. xiv + 156 pp.

We should all like to have a text-book on tropical soil biology, but we know, alas, that we cannot have it yet. It is like wanting dinner in the middle of the morning. The good things are not yet prepared, the eggs for the omelet perhaps not yet laid. In such circumstances a snack is acceptable; and if its slender content is set handsomely before us on plate and fine linen, with punctilious service, tasteful decorations, our host full of good conversation on the laws of dietetics, and a charge of 7s. 6d. for the occasion—who shall not sit down gracefully and enjoy it? The Barmecide Feast is an ancient Eastern joke, which the guests must take in good part. To be fair, it is a more generous further East to which we are invited, where nature is lavish even on a leached soil. The covers are not altogether empty.

Criticism must not be pressed further, except to say that the author seems better in biology than in soils, else he would not (for instance) perpetuate the old error that loss on ignition is a measure of soil organic matter, a statement especially untrue of the laterised soils on which his text is almost wholly based. The book is excellent light reading, and is illustrated with many first-rate photographs of Malayan forests, clearings, and secondary growths, all relevant to the subject-matter and in keeping with its picturesque yet thoughtful treatment throughout. There is a proportionately lengthy introduction on the physiography and vegetation of Malaysia, even including mention of its tin-mines; and the soil fauna is discussed inclusively, from the religious beliefs of the forest tribes to the lurking of tigers in uncontrolled cover crops. The reader is thus well informed of the setting of the soil processes when they are ultimately described to him, and is equipped the better to reconstruct their counterparts in the soils in which he is personally interested.

It need hardly be said that only very limited parts of our own territories have conditions akin to those of Malayan forests and rubber estates, but the principles of biological action in warm moist soils are probably fundamentally the same the world over. On the chance, at any rate, of that being so, we can all read with profit what is here written. We can hardly fail to understand it, mathematics and all, for nearly everything in the book is said at least twice over and then summarized; and there are good bibliographies and four indexes —all within 156 pages.

Amongst the noteworthy features of the book are a critical examination of the effect of burning when clearing for cultivation, and of the value (which the author considers has been greatly overestimated) of introduced leguminous plants as covers and nitrogen-restorers.

G.M.

TANGANYIKA TERRITORY: ANNUAL REPORT OF THE DEPARTMENT OF VETERINARY SCIENCE AND ANIMAL HUSBANDRY, 1934. Published by the Government Printer, Dar es Salaam; 5s.

This publication contains, in addition to the usual matter of an annual administration report, a considerable number of research papers by members of the scientific staff, all of them on subjects

of considerable interest and importance. An introductory section states the general policy of the department, and is elsewhere noted.

Disease Control.—The year began with four known foci of rinderpest, which were under treatment by the approved methods. Two of them flared up during the year and gave rise to major conflagrations, one in the Tabora-Singida area and the other in Central Masailand. The history of the latter outbreak showed a close association with game—buffalo, eland and wildebeeste. An outbreak among Ankole cattle in Bukoba caused exceptionally high mortality even in inoculated animals.

Pleuro-pneumonia was held responsible for comparatively few losses, and the quarantine measures in force were much reduced. The potentialities of the disease are nevertheless seriously regarded and complete suppression remains the objective.

In a discussion of East Coast fever the complex relationships existing between vegetative cover, ticks and cattle are explained. An equilibrium may be maintained between all three factors, a proportion of the calves being immunized through surviving early infection. The reduction of cover by drought or overgrazing suppresses the tick, and the check to the increase of cattle is removed. This is the situation maintained in the semi-arid areas, where overstocking is at its worst. If on the other hand the number of cattle on permanent grassland is seriously reduced (as by rinderpest or fly) the sources of infection are removed and a new stock of cattle grows up without immunity. Inevitably infection is reintroduced, and heavy mortality follows.

The position with reference to trypanosomiasis is that while important areas are being reclaimed from the tsetse fly, its encroachments continue on others, aggravating overstocking by driving back the herds into fly-free country. Controlled restocking of reclaimed areas is an urgent necessity of the situation.

Live Stock Trade.—Details given of the internal market for slaughter stock show encouraging figures of movements and sales. There is a market for every male animal in fair to good condition, and owners are now bringing forward these animals sufficiently freely to solve that part of the overstocking problem which is due to surplus mature males. The parts still to be solved are those due to small rubbishy males which traders will not buy, and to the increasing surplus of cows and heifers which owners will not sell readily, nor butchers kill readily.

The export of hides reached 3,628 tons, valued at £135,374, and of skins 364 tons, valued at £15,061. There was an increase of £10,000 in the value of ghee exported, and the internal trade was probably also greater than in any previous year.

Research.—The thirteen research papers published in the Report include studies on trypanosomiasis, on various questions of nutrition (by Mr. M. H. French), and of pasture and fodder questions and water conservation in relation to vegetation (by Mr. R. R. Staples).

W.N.